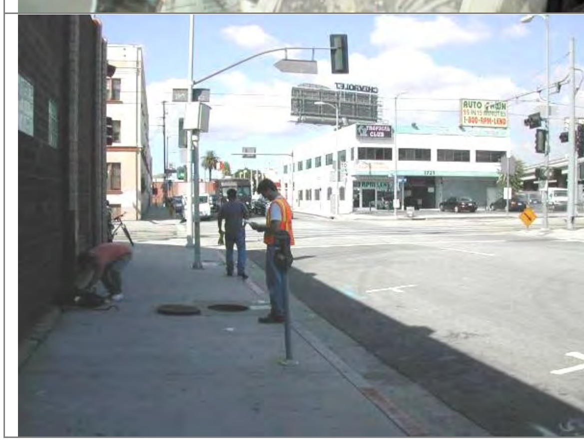
Site : CC-007-C **Location:** 18th and Flower St., South East Corner (Area 1 - Site G)

Curb Inlet Basket



Date inspected:
10/21/04

Comments: The presence of standing water indicates that this insert is clogged. It was retired after this visit.

Site : CC-007-C **Location:** 18th and Flower St., South East Corner (Area 1 - Site G) | Curb Inlet Basket

Site : CC-007-F **Location:** 18th St. & Flower St, Southwest corner (Area 1 - Site G) | FloGard

Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. This is a shallow catch basin with a relatively small amount of trash deposition.

Site : CC-007-F **Location:** 18th St. & Flower St, Southwest corner (Area 1 - Site G) FloGard

Date inspected:
2/4/04

Comments: Standing water indicates the filter media may be beginning to clog. Notice the floating absorbent boom of amorphous alumina silicate in the picture on the left.

Date inspected:
2/27/04

Comments: Not much changed from last inspection except the standing water had drained and there was slightly more trash and debris.

Site : CC-007-F **Location:** 18th St. & Flower St, Southwest corner (Area 1 - Site G) | FloGard



Date inspected:
3/23/04

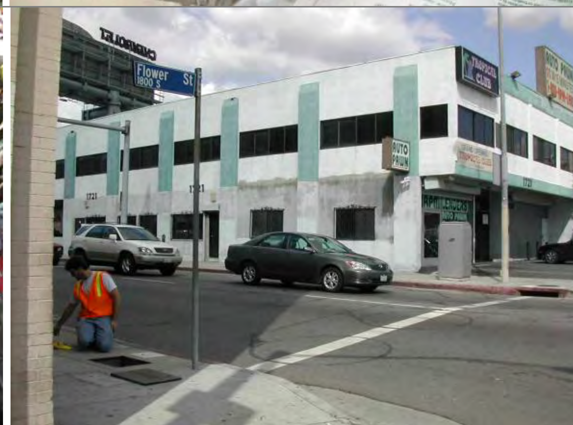
Comments: The insert appears to have reached its trash holding capacity and probably should be retired.

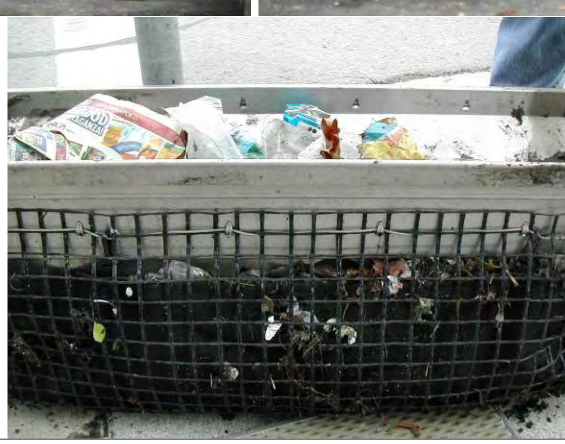


Date inspected:
6/30/04

Comments: As before, this insert appears to be at capacity and is currently overflowing with trash. Much of the trash appears to have been transported by wind rather than runoff.

Site : CC-007-F **Location:** 18th St. & Flower St, Southwest corner (Area 1 - Site G) | FloGard

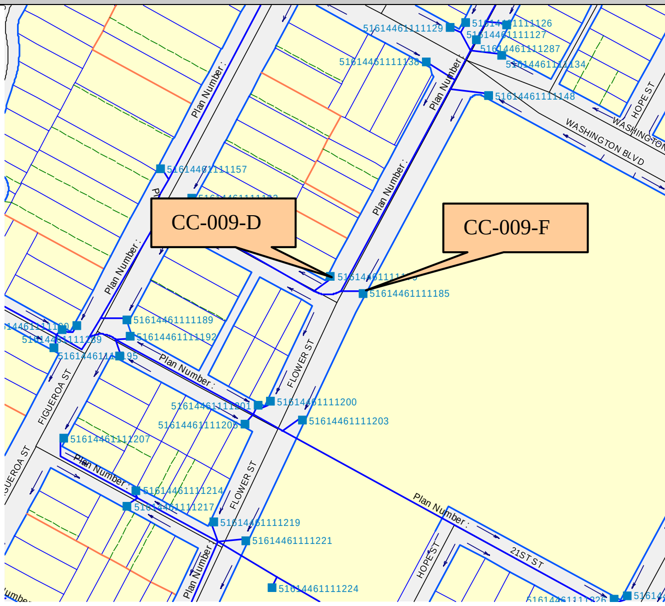




Date inspected:
10/21/04

Comments: Appears that significant trash has bypassed the insert. It was retired after this visit.

Area 1 - Site H



Looking upstream (~north) of CC-009F

Intersection	20th St & Flower St
No. of Installations	2

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-009-D	DrainPac	382592	3766501	3.5	3.2	3.7
CC-009-F	Flogard+Plus	382699	3766287	3.2	3.5	5

Site : CC-009-D **Location:** 20th and Flower St., West Side (Area 1 - Site H) | DrainPac

Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream.

Site : CC-009-D **Location:** 20th and Flower St., West Side (Area 1 - Site H)	DrainPac
  	
  	**Date inspected:** 2/4/04 **Comments**: Notice the insert is nearly at its flow capacity during this runoff event, but is still passing the flow.

<table>
<tr><th colspan="2">**Site :** CC-009-D **Location:** 20th and Flower St., West Side (Area 1 - Site H)</th><th>DrainPac</th></tr>
<tr><td></td><td></td><td>**Date inspected:**
2/27/04

Comments: Very little accumulation of trash since last site visit.</td></tr>
<tr><td>
</td><td>
</td><td>**Date inspected:**
3/23/04

Comments: There doesn't appear to be a lot of trash, but notice the build-up of fine sediment on the surface of the filter.</td></tr>
<tr><td></td><td></td><td>**Date inspected:**
6/30/04

Comments: As compared to the last visit, a significant amount of trash has accumulated in the insert, but it still has remaining capacity. Some wind-blown trash appears to have bypassed the unit.</td></tr>
</table>

Site : CC-009-D **Location:** 20th and Flower St., West Side (Area 1 - Site H) | DrainPac





Date inspected:
10/21/04

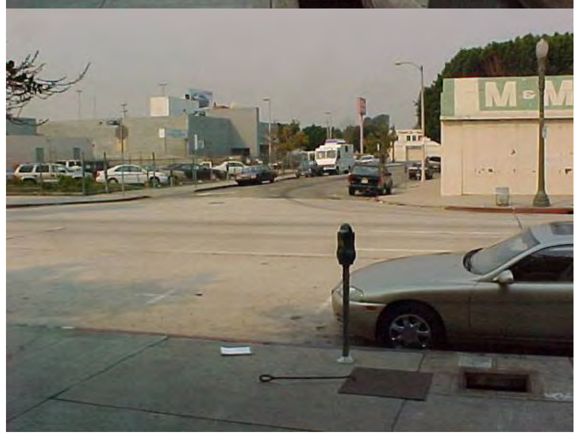
Comments: Mostly sediment in this insert. Appears to have been cleaned since last visit.

Site : CC-009-F **Location:** 20th and Flower St., East Side (Area 1 - Site H) | Flo-Gard

Site : CC-009-F **Location:** 20th and Flower St., East Side (Area 1 - Site H)

Flo-Gard




Date inspected:
10/24/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream.


Date inspected:
2/4/04

Comments: These pictures were taken during an actual event. The effluent from the insert was relatively clean and the inlet bottom was also relatively clean

Site : CC-009-F **Location:** 20th and Flower St., East Side (Area 1 - Site H) | Flo-Gard

Date inspected:
2/27/04

Comments: Notice the absorbent boom has nearly floated out of the device.

Date inspected:
3/23/04

Comments: A later inspection reveals the debris is still trapped in the insert. The upper portion of the insert appears to be less effective for trapping sediment and small debris, so this insert is at capacity even though it may not appear full. Also, the absorbent is not likely providing much treatment with the way it is hanging out of the basket.

Site : CC-009-F **Location:** 20th and Flower St., East Side (Area 1 - Site H)

Flo-Gard





Date inspected:
6/30/04

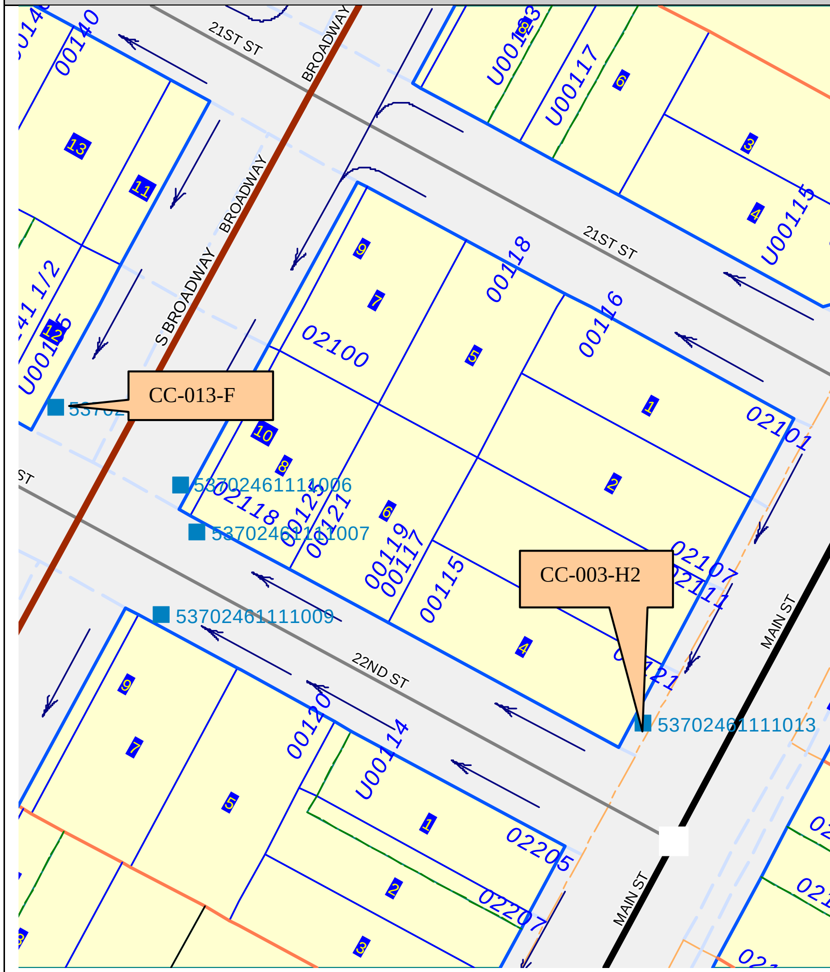
Comments: The absorbent with this insert appears to have been dislodged.


Date inspected:
10/21/04

Comments: As compared to the last visit, this insert appears have been cleaned and is in good working condition.

Site : CC-009-F **Location:** 20th and Flower St., East Side (Area 1 - Site H) | Flo-Gard

Area 1 - Site I



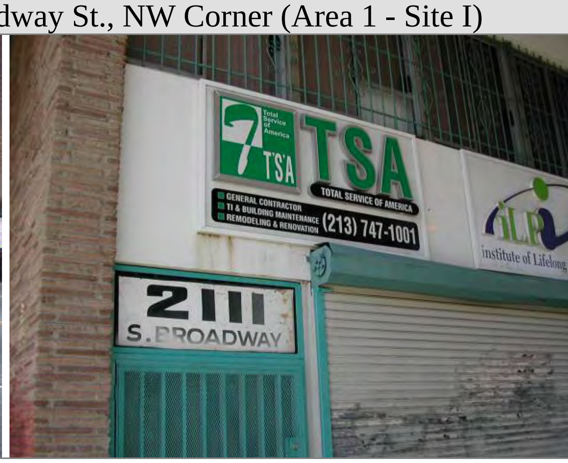
Looking west from across the street from CC-0130F

Looking south toward CC-003-H2 from Main

Intersection	22nd St and Broadway St. 22nd St. & Main.
No. of Installations	2

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-013-F	Flogard+Plus	383060	3765882	3.5	3.2	3.4
CC-003-H2	Hydro-Kleen	383159	3765836	3.6	3.5	2.7

Site : CC-013-F **Location:** 22nd and Broadway St., NW Corner (Area 1 - Site I) — Flo-Gard



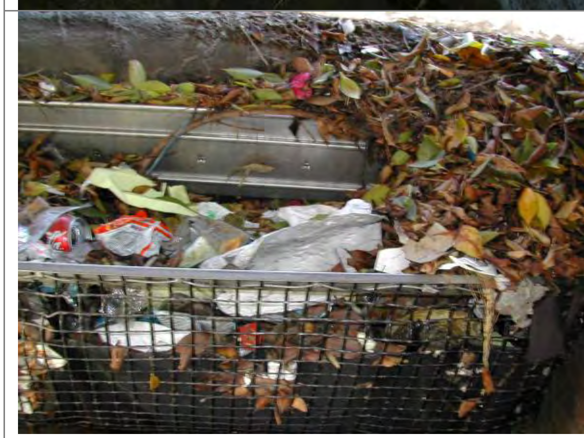
Date inspected:
10/24/03

Comments: Initial site visit. Top left photo is looking across the street toward the curb inlet.

Site : CC-013-F **Location:** 22nd and Broadway St, NW Corner (Area 1 - Site I) | Flo-Gard


Date inspected:
2/4/04

Comments: This was the first site visit after installation and one storm event. The insert is already nearly at capacity.




Date inspected:
2/27/04

Comments:
About two weeks later, this site was already overwhelmed with leaves and trash.

Date inspected:
3/23/04

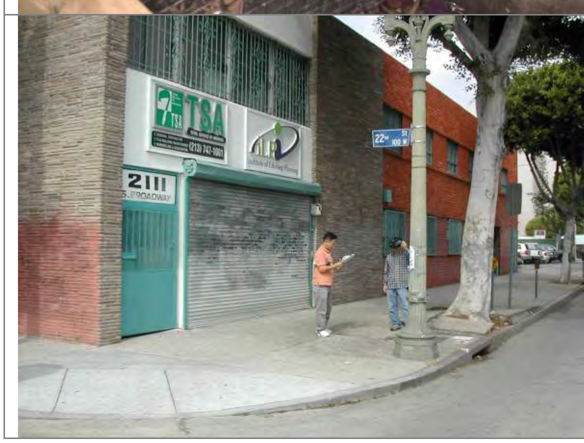
Comments: Later inspections still show a lot of the leaves and trash were still trapped in the insert. The insert is completely full at this point and needs to be cleaned.

Site : CC-013-F **Location:** 22nd and Broadway St., NW Corner (Area 1 - Site I) | Flo-Gard




Date inspected:
6/30/04

Comments: As before, this insert is completely overwhelmed with trash and debris and needs to be retired.



Date inspected:
10/21/04

Comments: It was retired after this visit.

Site : CC-013-F **Location:** 22nd and Broadway St, NW Corner (Area 1 - Site I) | Flo-Gard

Site : CC-003-H2 **Location:** 22nd St. & Main (Area 1 - Site I) | Hydro Kleen

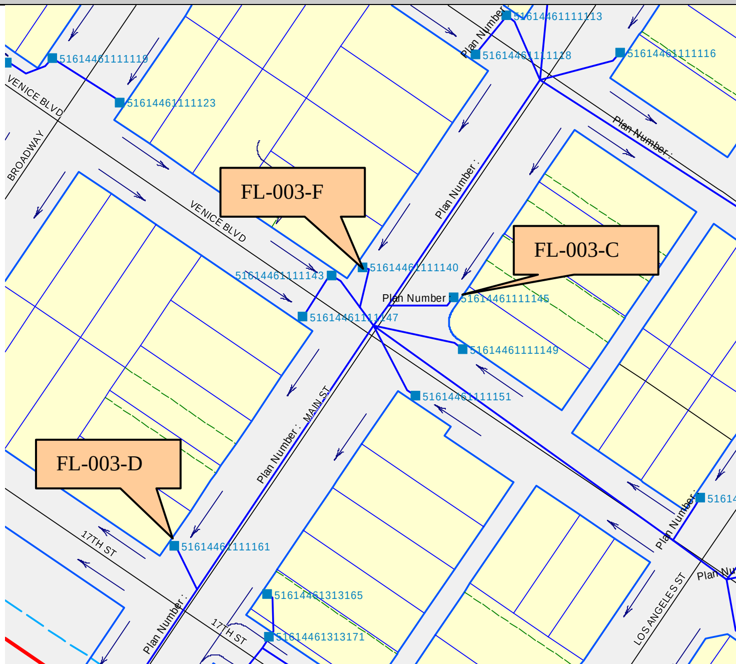
Date inspected:
10/24/03

Comments: Initial site visit. Top left photo is looking upstream; top right photo is looking downstream. Notice about a garbage bag worth of trash had been deposited in the catch basin. This site was originally an FL site, but was changed due to installation timing conflicts.

Site : CC-003-H2 **Location:** 22nd St. & Main (Area 1 - Site 1)		Hydro Kleen
		
		**Date inspected:** 2/4/04 **Comments:** The insert had not yet been installed at the time of this visit.
		**Date inspected:** 2/27/04 **Comments:** This site was only briefly inspected during this visit and has been inadvertently overlooked during subsequent site visits because it was thought to be an FL site. The catch basin was cleaned prior to installation of the insert.
		**Date inspected:** 03/22/05 **Comments:** After this visit, this insert was taken to the laboratory for its final tests.

Site : CC-003-H2 **Location:** 22nd St. & Main (Area 1 - Site 1)	Hydro Kleen
	

Area 1 - Site J

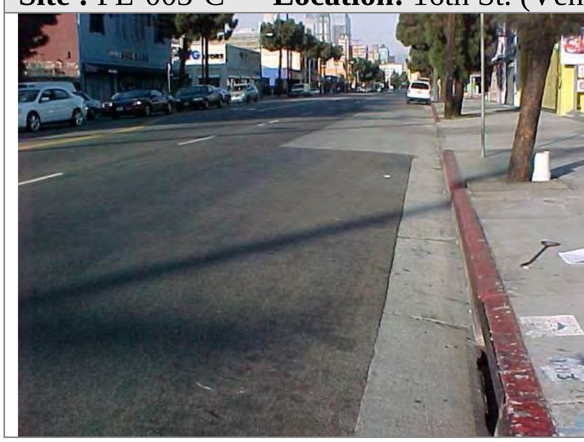


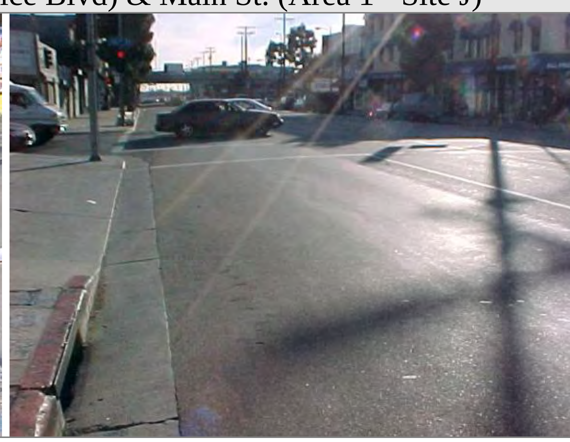
Looking north from FL-003-C

Intersection	16th St. (Venice Blvd) & Main St. 17th St. & Main St.
No. of Installations	3

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
FL-003-D	DrainPac	383386	3766539	3.5	3.2	3
FL-003-F	Flogard+Plus	383452	3766626	3.5	3.2	3.6
FL-003-C	Curb Inlet Basket	383550	3766421	3.5	3.2	3.0

Site : FL-003-C **Location:** 16th St. (Venice Blvd) & Main St. (Area 1 - Site J) | Curb-Inlet Basket





Date inspected:
10/24/03

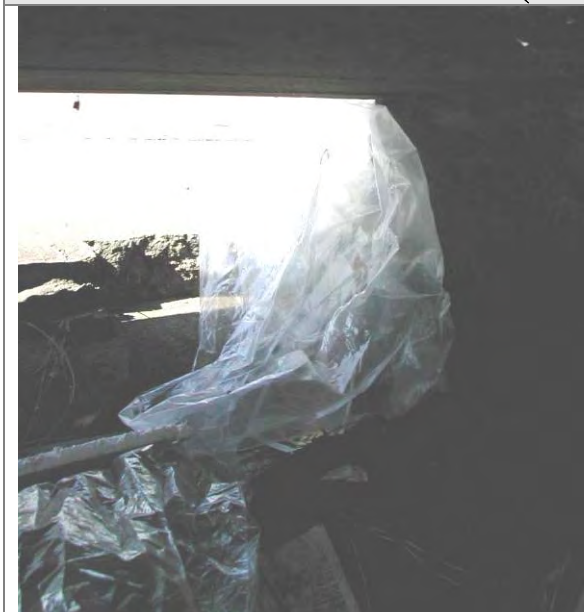
Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. There is a Chevron gas station on the corner that may be contributing to some of the runoff to this CB.

Site : FL-003-C **Location:** 16th St. (Venice Blvd) & Main St. (Area 1 - Site J)	Curb-Inlet Basket

Date inspected:
2/4/04

Comments: Notice the coarse sand accumulating on the shelf of this insert. This may help reduce the chance of clogging, but the plastic bags are the overflow screen. Note the insert has been removed in the bottom picture for subsequent transport to the UCLA testing laboratory.

Site : FL-003-C **Location:** 16th St. (Venice Blvd) & Main St. (Area 1 - Site J) | Curb-Inlet Basket




Date inspected:
2/27/04

Comments: Note the insert has been removed for laboratory testing and only the debris shelf and mounting brackets remain.


Date inspected:
10/21/04

Comments: The contents of this insert were removed and a new absorbent was installed in preparation for the wet season.


Date inspected:
03/22/05

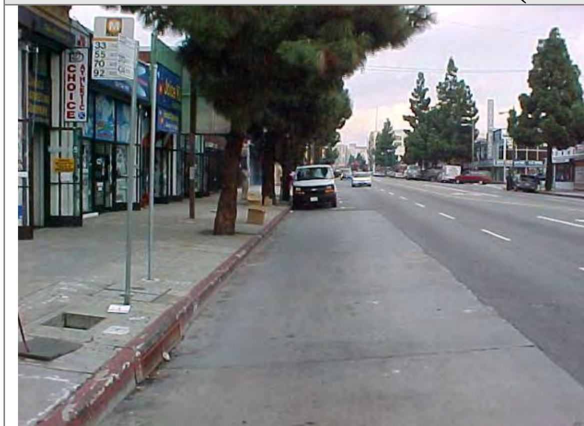
Comments: Since the last visit this insert shows significant accumulation of pine needles and sediment. After this visit, this insert was taken to the laboratory for its final tests.

Site : FL-003-C **Location:** 16th St. (Venice Blvd) & Main St. (Area 1 - Site J)	Curb-Inlet Basket





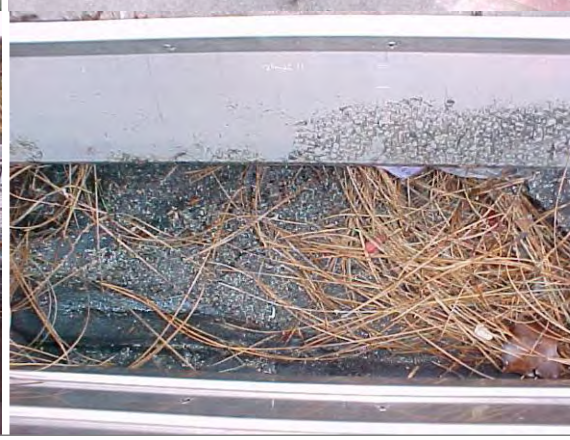
Site : FL-003-F **Location:** 16th St. (Venice Blvd) & Main St. (Area 1 - Site J) | FloGard Plus




Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. Notice the inlet to this CB has an expanded metal screen, so that only small debris and sediment makes it into the CB.



Date inspected:
2/4/04

Comments: This is the first site visit after installation. Notice the relative minor amount of sediment and debris in this insert - mostly pine needles and sand. The bottom of the catch basin is clean. This insert was removed from the CB and subsequently transported to the UCLA laboratory during this visit.

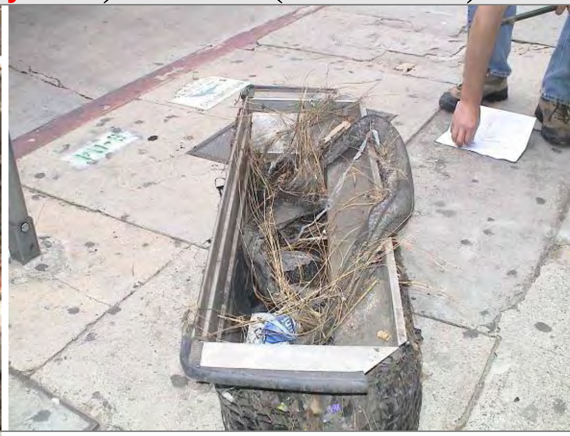
Site : FL-003-F **Location:** 15th St. (Venice Blvd) & Main St. (Area 1 - Site J) | FloGard Plus

Date inspected:
10/21/04

Comments:

Date inspected:
03/22/05

Comments: As with many other sites with this insert, the absorbent media is sticking out of the insert. After this visit, this insert was taken to the laboratory for its final tests.

Site : FL-003-F **Location:** 16th St. (Venice Blvd) & Main St. (Area 1 - Site J)		FloGard Plus
		
		

Site : FL-003-D **Location:** 17th St. & Main St. (Area 1 - Site J) | DrainPac



Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. This site apparently receives lots of leaf litter and street trash. Notice the outlet in the bottom photo is nearly clogged with debris.



Date inspected:
2/4/04

Comments: This is the first site visit after installation and one rain event. Only a minor amount of debris was found in the insert. This insert was removed from the CB and subsequently transported to the UCLA laboratory during this visit.

Site : FL-003-D **Location:** 17th St. & Main St. (Area 1 - Site J) | DrainPac

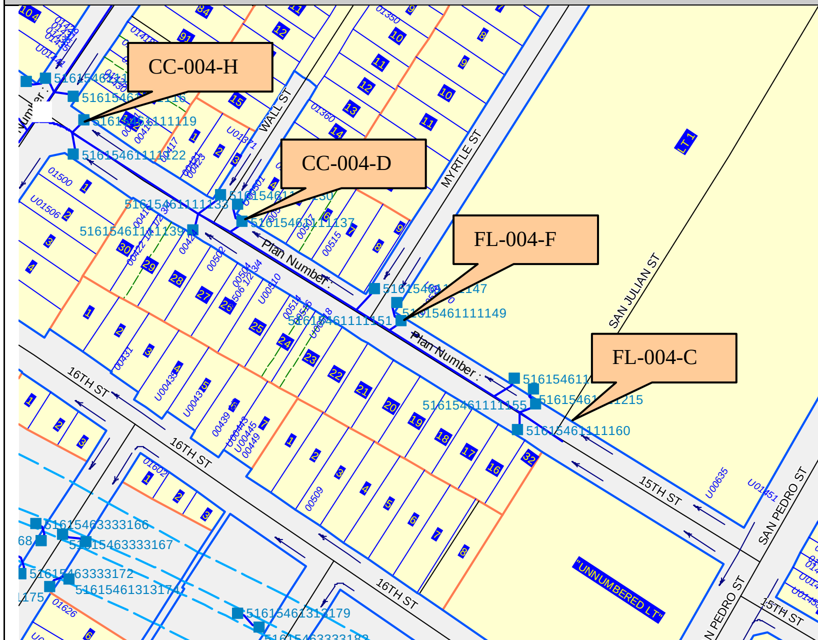





Date inspected:
03/22/05

Comments: After this visit, this insert was taken to the laboratory for its final tests.

Area 1 - Site K

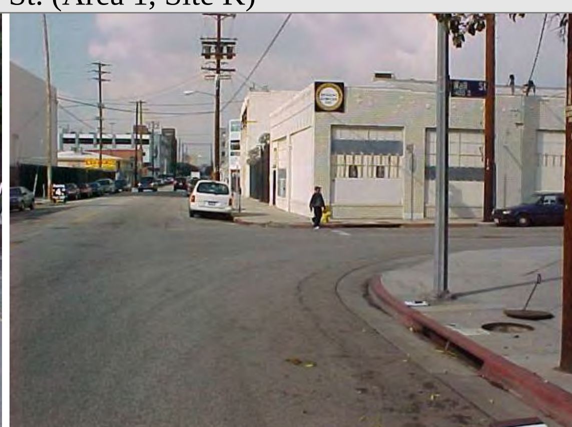


Looking east from west side of intersection.

Intersection	15th and Maple St. to San Pedro St.
No. of Installations	4

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-004-D	DrainPac	383876	3766430	7	4.3	3.1
FL-004-F	Flogard+Plus	383940	3766382	3.6	3.2	3.6
FL-004-C	Curb Inlet Basket	384034	3766333	3.5	3.2	3.6
CC-004-H	Hydro-Kleen	383800	3766465	3.5	3.2	3.3

Site : CC-004-D **Location:** 15th and Wall St. (Area 1, Site K) | DrainPac



Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. This was originally an FL site, but was changed to a CC site because the inlet was 7' and the laboratory is set up for 3.5' wide inserts.

Site : CC-004-D **Location:** 15th and Wall St. (Area 1, Site K) | DrainPac

Date inspected:
1/30/04

Comments: Couple of days after installation. No debris inside of insert.

Date inspected:
3/23/04

Comments: Still relatively clean since last visit; significant capacity remaining.

Site : CC-004-D **Location:** 15th and Wall St. (Area 1, Site K)	DrainPac
     	**Date inspected:** 6/30/04 **Comments:** This inserts has not received much additional trash and debris since last inspection and is still well below capacity.
	**Date inspected:** 10/21/04 **Comments:** As before, this site received a relatively small amount of debris. This site was retired after this visit.

Site : CC-004-H **Location:** 15th and Maple St. (Area 1, Site K) HydroKleen

Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. Note that black widows were observed in this catch basin.
This site originally was to be an FL site, but it was decided that the screen would not allow for a good comparison between technologies that do not have screens. The overburden of trash loadings now observed for nearly all of the sites indicates that sites with these screens may be among the best for evaluating the performance of catch basin inserts at removing fine sediment and oil and grease.

Date inspected:
3/23/04

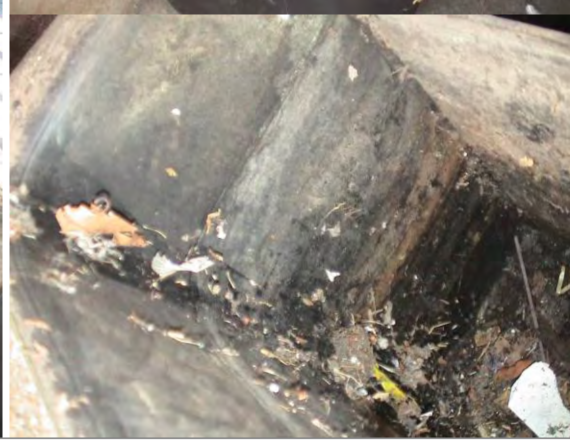
Comments: This is the only site that already had a curb screen. Notice how clean the insert is with mostly only water and oil in the sedimentation chamber of the insert.

Site : CC-004-H **Location:** 15th and Maple St. (Area 1, Site K) | HydroKleen





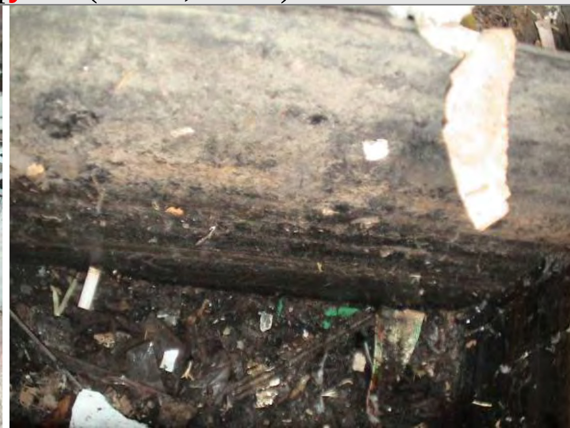


Date inspected:
6/30/04

Comments: This insert is still relatively clean and the standing water has nearly all evaporated. This indicates the curb side screen is a very effective method for keeping catch basin inserts in working order.

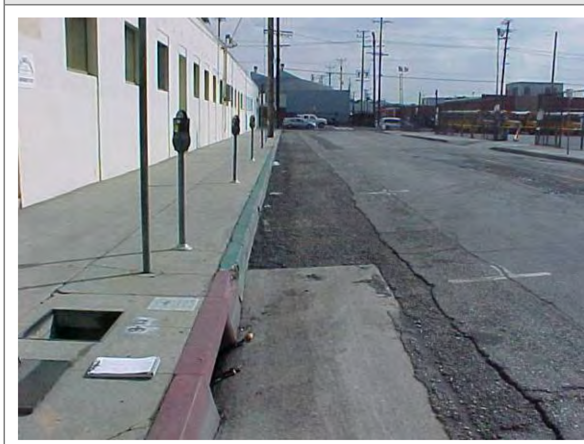
Site : CC-004-H **Location:** 15th and Maple St. (Area 1, Site K) | HydroKleen

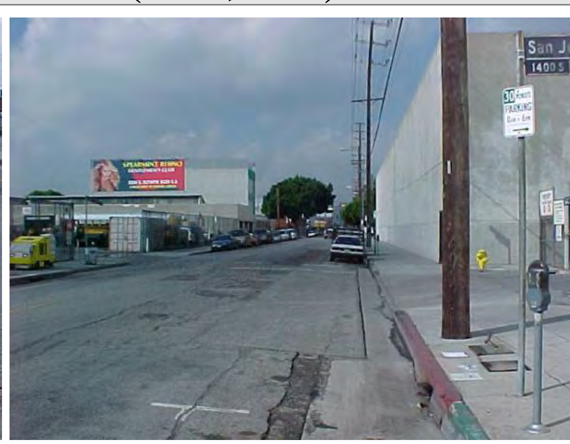


Date inspected:
10/21/04

Comments: As before, this site showed limited trash accumulation, indicating the effectiveness of the trash screen.

Site : FL-004-C **Location:** 15th and San Julian St. (Area 1, Site K) | Curb-Inlet Basket





Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. This catch basin is located across the street from the LA Unified School District bus storage yard. Notice this catch basin is in-line with the

Site : FL-004-C **Location:** 15th and San Julian St. (Area 1, Site K) Curb-Inlet Basket

storm drain system (e.g., there are both inlet and outlet pipes) and there is evidence of dry-weather flows.

Date inspected:
2/4/04

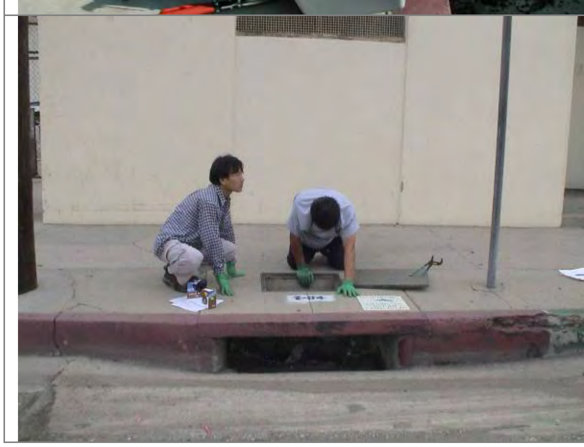
Comments: Couple of days after installation and one storm event. Notice the school bus parked in next to curb in the top right photo. This street gets lots of school bus traffic because the LACUSD properties nearby. The bottom left photo shows the shelf and mounting bracket of the insert after removal. The insert was subsequently taken to the UCLA laboratory for testing.

Site : FL-004-C **Location:** 15th and San Julian St. (Area 1, Site K)

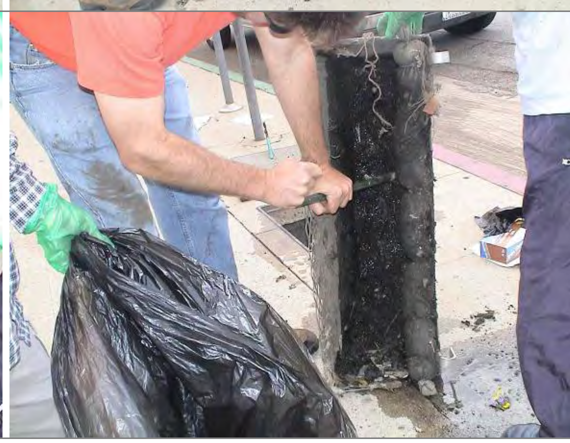
Curb-Inlet Basket

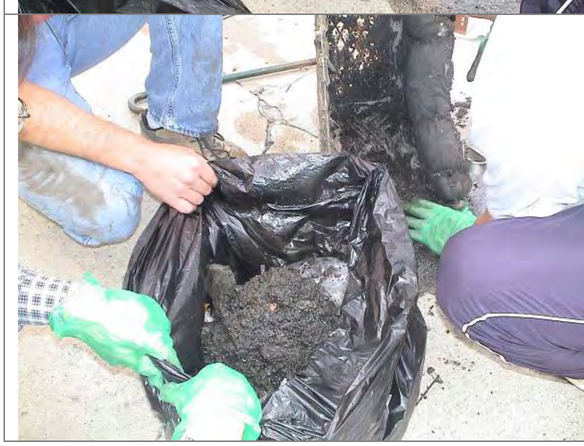
Date inspected:
10/21/04

Comments: During this inspection it was noted that the City had installed one of their complete capture devices. Luckily, our insert was compatible with this design and did not get removed.

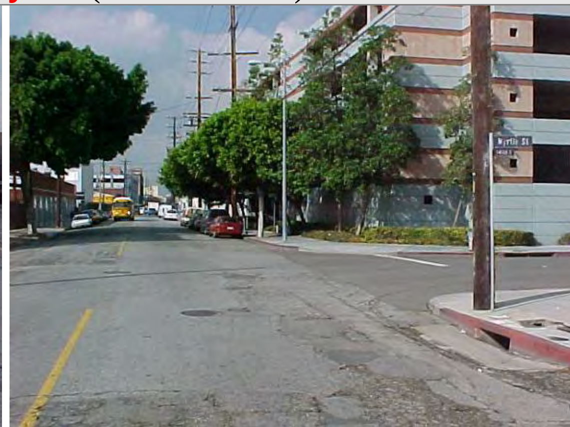


Site : FL-004-C **Location:** 15th and San Julian St. (Area 1, Site K) | Curb-Inlet Basket





Site : FL-004-F **Location:** 15th and Myrtle St. (Area 1 - Site K) | Flo-Gard Plus


Date inspected:
12/10/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. This is an inline catch basin with a small amount of trash and minor dry weather flow.

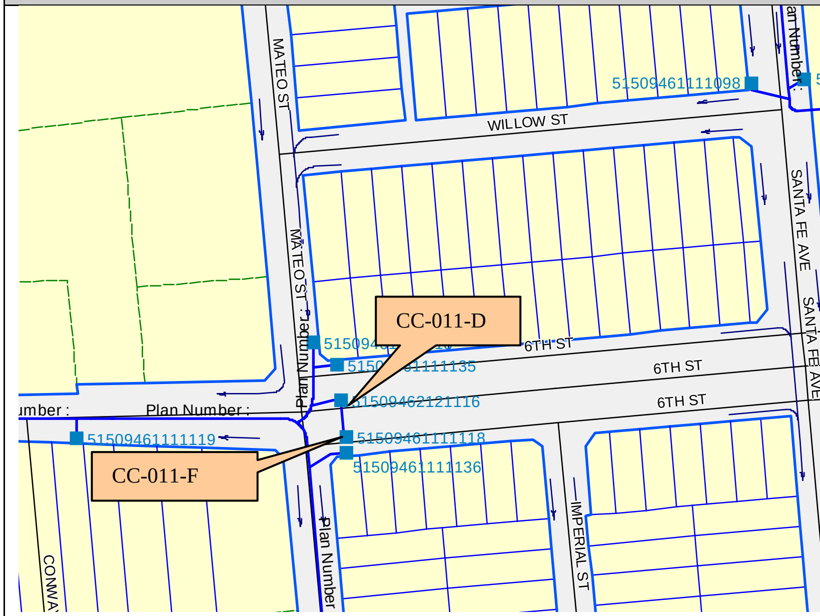
Date inspected:
2/4/04

Comments: First site visit after installation and one storm event. This catch basin appears to have only received a small amount of trash and debris. The insert was removed and subsequently transported to the UCLA laboratory for testing.

Site : FL-004-F **Location:** 15th and Myrtle St. (Area 1 - Site K)		Flo-Gard Plus
		
		**Date inspected:** 10/21/04 **Comments:** The insert at this site was removed by the City and replaced with one of their complete capture devices.
 	 	**Date inspected:** 03/22/05 **Comments:** After this visit, this insert was taken to the laboratory for its final tests.

Site : FL-004-F **Location:** 15th and Myrtle St. (Area 1 - Site K)	Flo-Gard Plus
	

Area 2 - Site L

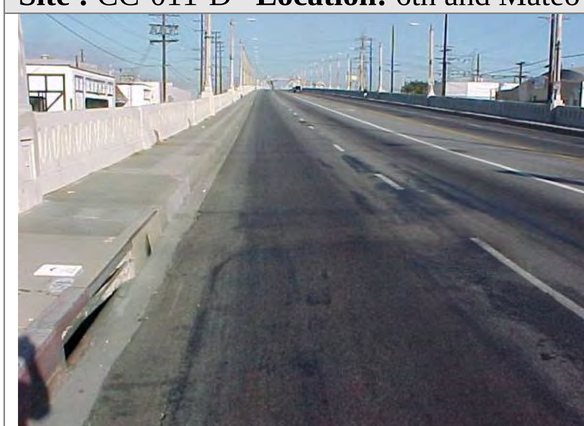


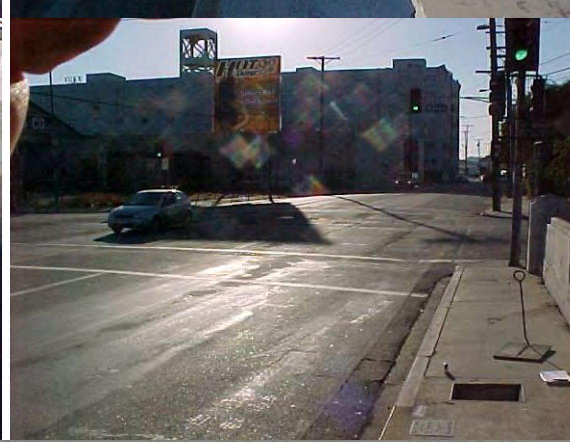
Looking upstream (east)

Intersection	6th St. & Mateo St.
No. of Installations	2

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-011-D	DrainPac	386309	3766893	7	2.2 (bottom) 4.6 (top)	6.7
CC-011-F	Flogard+Plus	386226	3767081	7	2.8	5.9

Site : CC-011-D **Location:** 6th and Mateo St. (Area 2 - Site L) | DrainPac





Date inspected:
10/24/03

Comments: Initial site visit. Top two photos are looking upstream; Middle left is looking downstream. Note all runoff to this site is roadway runoff.

Site : CC-011-D **Location:** 6th and Mateo St. (Area 2 – site L) | DrainPac


Date inspected:
2/4/04

Comments: This was the first site visit after installation. Some trash was present, but not nearly at capacity.




Date inspected:
3/23/04

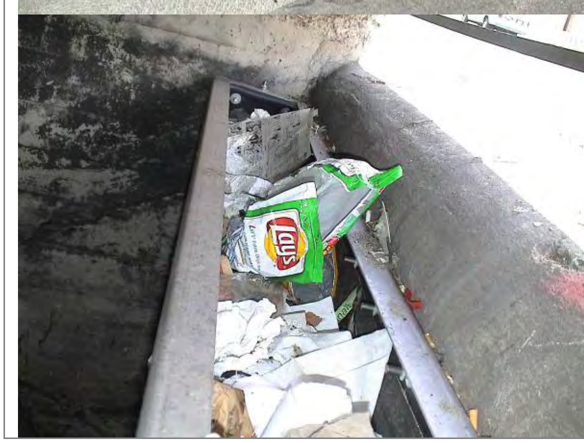
Comments: Significant trash and debris captured in the insert since last visit. Appears to be at capacity and should be cleaned before the next wet season.

Site : CC-011-D **Location:** 6th and Mateo St. (Area 2 - site 1) | DrainPac





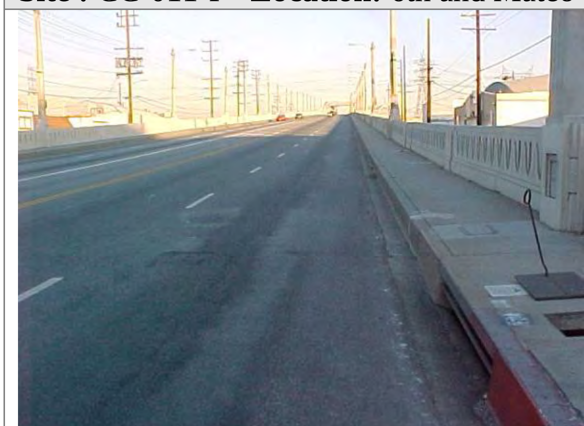





Date inspected:
6/30/04

Comments: More trash and debris have accumulated in this insert. It probably should be retired during the next site visit.

Site : CC-011-D **Location:** 6th and Mateo St. (Area 2 - Site L)	DrainPac
 	

Site : CC-011-F **Location:** 6th and Mateo St., South East Corner (Area 2 - Site L)	FloGard
    	**Date inspected:** 10/24/03 **Comments:** Initial site visit. Top two photos are looking upstream; Middle left is looking downstream. All runoff to this site is roadway runoff. Notice the amount of trash deposited in the catch basin is much less than the catch basin across the street.

Site : CC-011-F **Location:** 6th and Mateo St., South East Corner (Area 2 - Site L) | FloGard

Date inspected: 2/4/04

Comments: This was the first site visit after installation and one storm event.

Date inspected: 3/23/04

Comments: Notice the upstream insert has collected significantly more trash and debris than the downstream insert, indicating that runoff is the primary transport mechanism. However, wind transport appears to also contribute significantly.

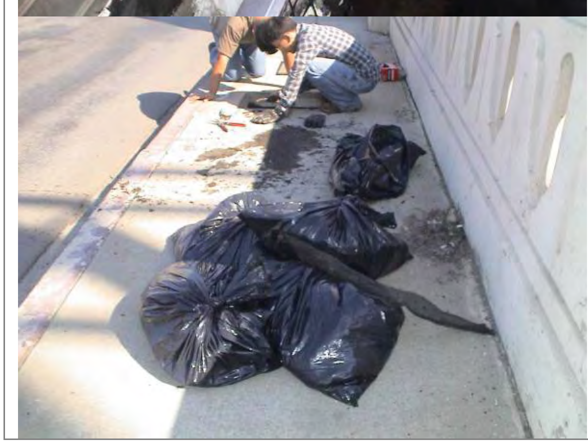
Site : CC-011-F **Location:** 6th and Mateo St., South East Corner (Area 2 - Site L)		FloGard
		
		**Date inspected:** 6/30/04 **Comments:** Since the last visit, not much additional trash and debris have accumulated in the insert. Nonetheless, it is nearly at capacity and should be retired.
		
		**Date inspected:** 10/22/04 **Comments:** As compared to the last visit, this insert appears to have been cleaned, but still a significant amount of debris had been captured.

Site : CC-011-F **Location:** 6th and Mateo St., South East Corner (Area 2 - Site L)	FloGard

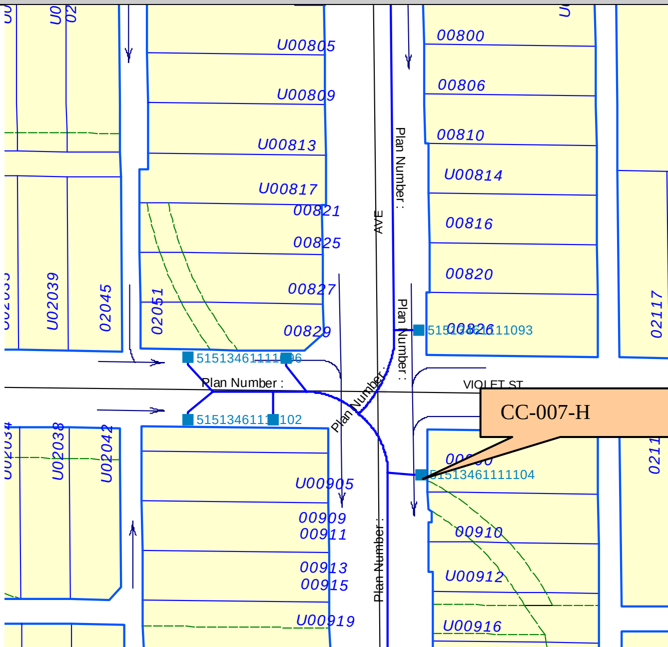









Area 2 - Site M

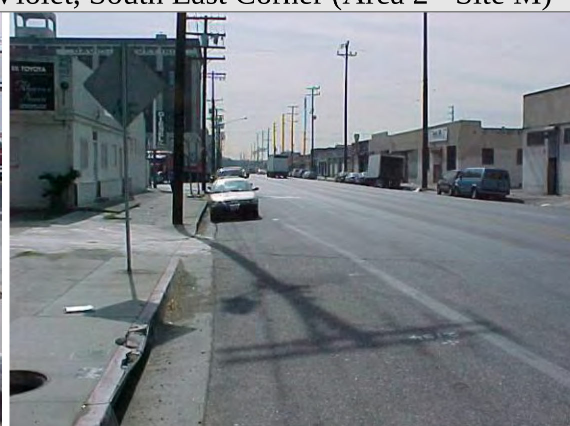


Looking toward intersection from Santa Fe (looking North)

Intersection	Santa Fe & Violet SE
No. of Installations	1

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-007-H	Hydro-Kleen	386536	3766241	7.0	3.0	4.0

Site : CC-007-H **Location:** Santa Fe and Violet, South East Corner (Area 2 - Site M) | HydroKleen



Date inspected:
10/21/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. Notice the damage to the 7' curb inlet.

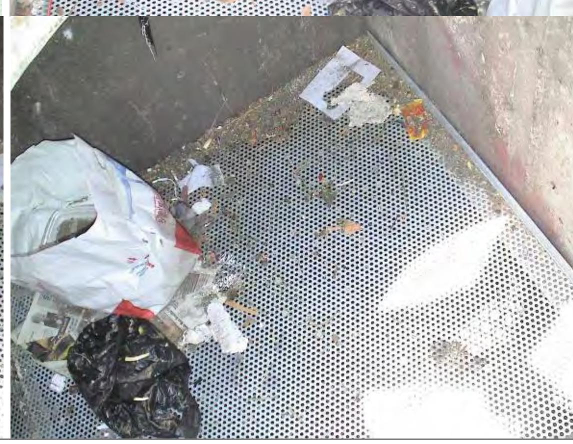
Site : CC-007-H **Location:** Santa Fe and Violet, South East Corner (Area 2 - Site M)		HydroKleen
		
 		**Date inspected:** 2/4/04 **Comments:** Two devices were placed in this catch basin to accommodate the larger opening. It appears runoff is reaching both inserts, but the floatable debris is accumulating more on the upstream end (top left photo).
		**Date inspected:** 3/23/04 **Comments**: Evidence of by-pass shown by plastic bag hanging over the top of the insert.

B95

Site : CC-007-H **Location:** Santa Fe and Violet, South East Corner (Area 2 - Site M) | HydroKleen





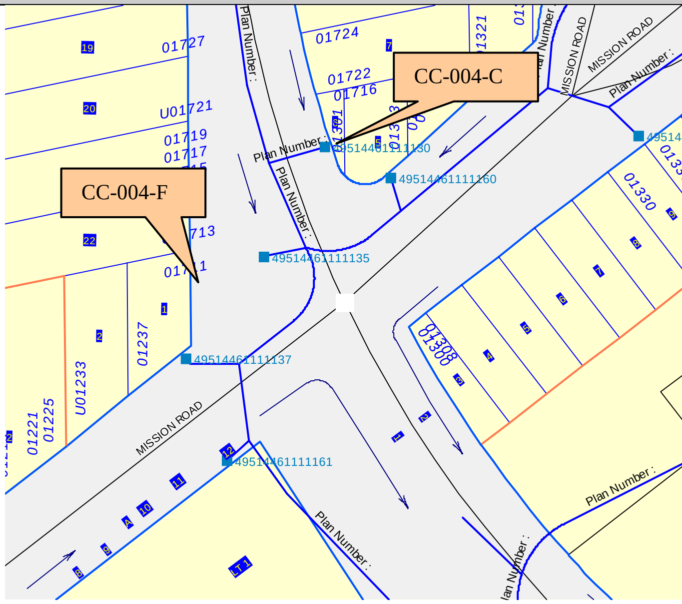
Date inspected:
6/30/04

Comments: Without our knowledge, the insert has been removed and replaced with this trash screening device by the City. Wing Tam is trying to locate our insert so that we can take it to the UCLA laboratory for its final analysis.

Site : CC-007-H **Location:** Santa Fe and Violet, South East Corner (Area 2 - Site M)	HydroKleen
 	

B97

Area 2 - Site N

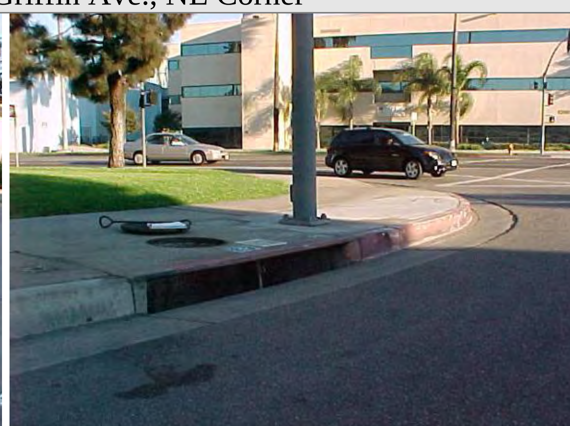
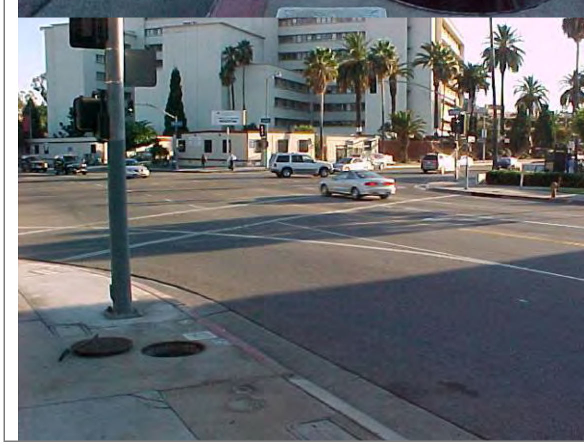



Looking across street from 004-C (southeast)

Intersection	Mission Rd. & Griffin Ave.
No. of Installations	2

Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-004-C	Curb Inlet Basket	388302	3769613	7	3.1	3.3
CC-004-F	Flogard+Plus	388208	3769792	7	3.1	5

Site : CC-004-C **Location:** Mission and Griffin Ave., NE Corner — Curb-Inlet Basket


Date inspected:
10/20/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream.

Site : CC-004-C **Location:** Mission and Gyffin Ave., NE Corner | Curb-Inlet Basket

Date inspected:
2/4/04

Comments: This visit was shortly after installation.

Date inspected:
3-23-04

Comments: Sediment and pine needle debris have completely filled this insert. However, there is no evidence of clogging or significant bypass.

Site : CC-004-C **Location:** Mission and Griffin Ave., NE Corner | Curb-Inlet Basket

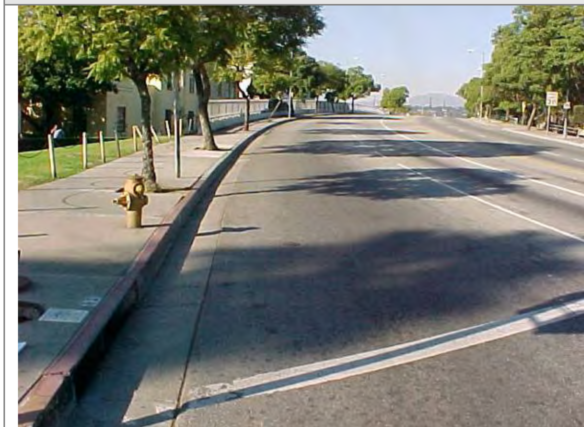
Date inspected: 6/30/04

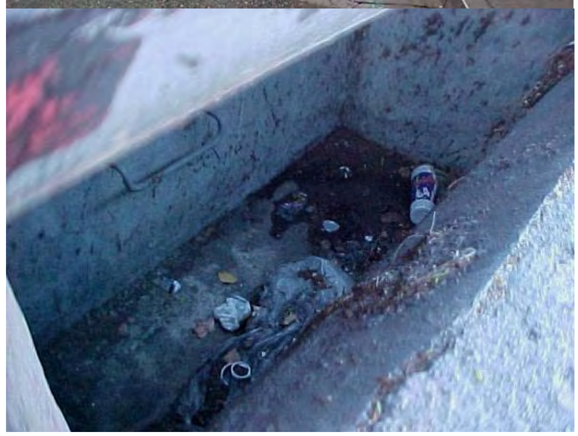
Comments: This insert has recently been cleaned. Notice the absorbent boom is no longer present; probably due to vactor truck.

Date inspected: 10/22/04

Comments: This insert appears to have been recently cleaned and the absorbent boom removed.

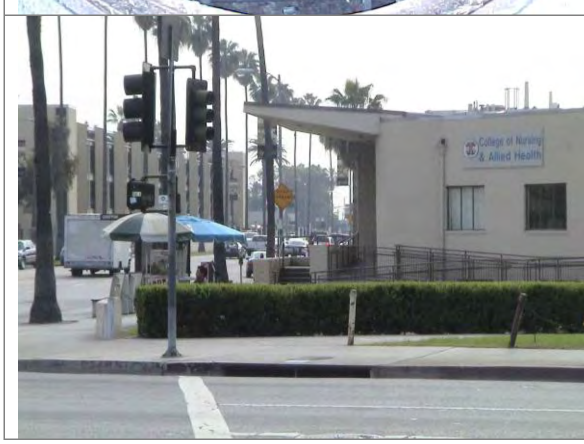
Site : CC-004-F **Location:** Mission and Gryffin Ave., NW Corner | Flo-Gard




Date inspected:
10/20/03

Comments: Initial site visit. Top left photo is looking upstream; top right is looking downstream. There was about 1 garbage bag of trash present in the bottom of the catch basin during this visit. Notice the location of this catch basin is on the edge of the road, not in the middle as shown in the location map above.



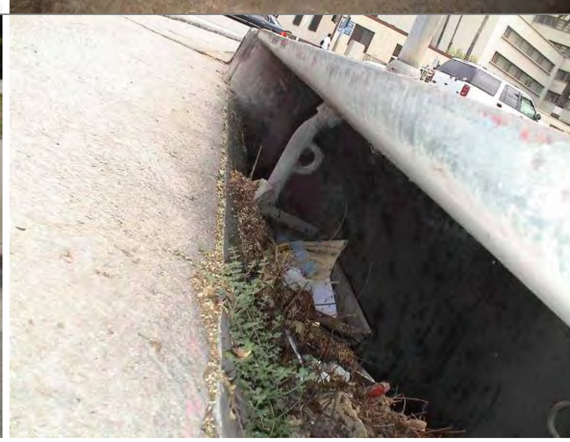
Date inspected:
2/4/04

Comments: This visit was shortly after installation. The installation consists of two Flo-Gard Plus inserts side-by-side to cover the entire 7' curb opening.

Site : CC-004-F **Location:** Mission and Gryffin Ave., NW Corner | Flo-Gard

Date inspected:
3/23/04

Comments: As with the one across the street, this insert is filled with pine needles almost to capacity, but notice only the upstream insert is at capacity.



Date inspected:
6/30/04

Comments: Similar to the one across the street, this insert was recently cleaned as indicated by the month and year painted on the curb. However, both installations are at full capacity indicating the insert was not actually cleaned.

Site : CC-004-F **Location:** Mission and Gryffin Ave., NW Corner | Flo-Gard



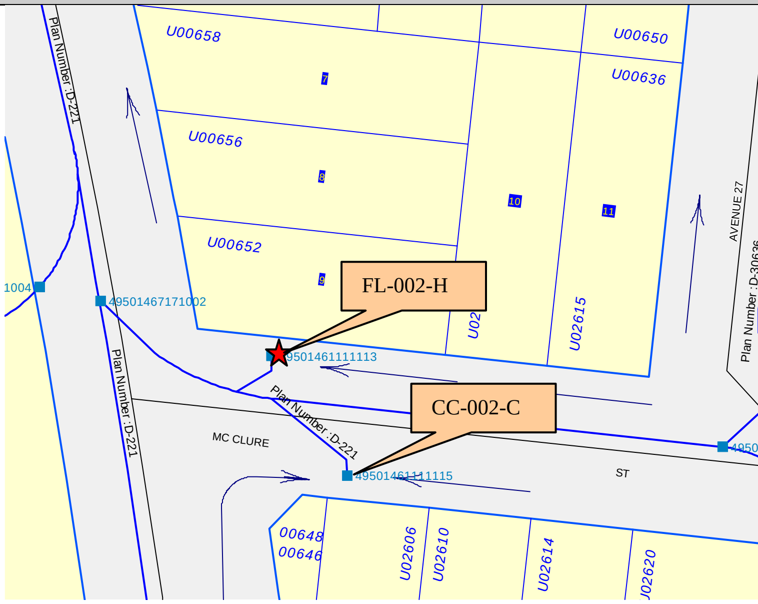





Date inspected:
10/22/04

Comments: The upstream insert was at capacity during this visit and the downstream insert about half full. The insert was removed and the contents extracted for laboratory sieve analysis.

Area 2 - Site O



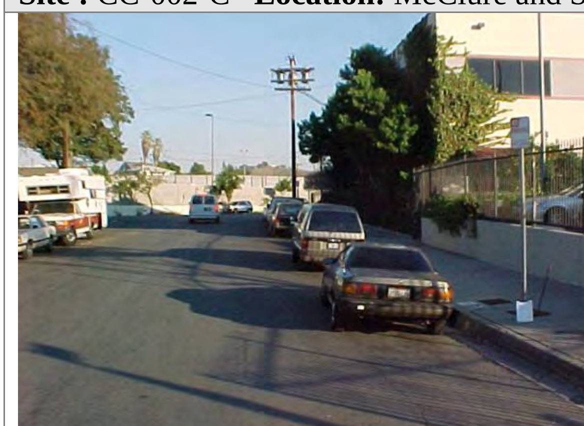
Looking upstream from 002-H (east)

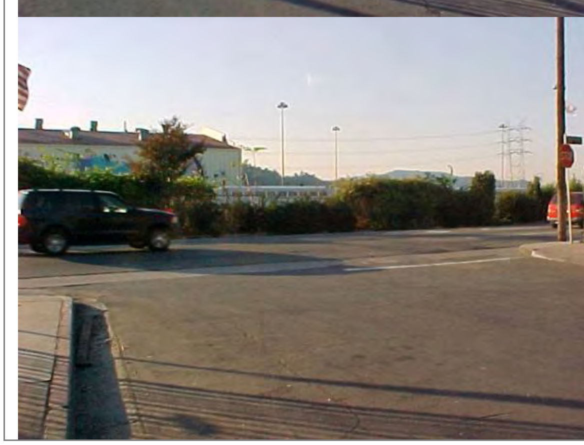
Intersection	Mc Clure St. & San Fernando Rd.
No. of Installations	2

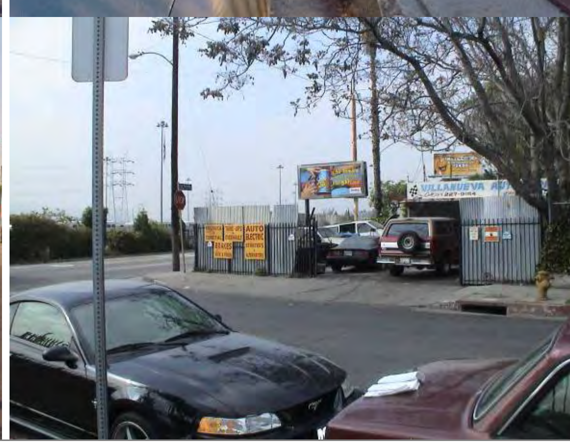
Inlet Number	Technology Type	Easting	Northing	Measurements (see Figure 2)		
				A-Curb Opening	B-Drain inside width	C-Drain inside depth
CC-002-C	Curb Inlet Basket	386929	3772531	3.4	3.2	3.4
FL-002-H	Hydro-Kleen	387010	3772343	3.7	3.2	3.3

Site : CC-002-C **Location:** McClure and San Fernando Rd., S Corner

Curb-Inlet Basket







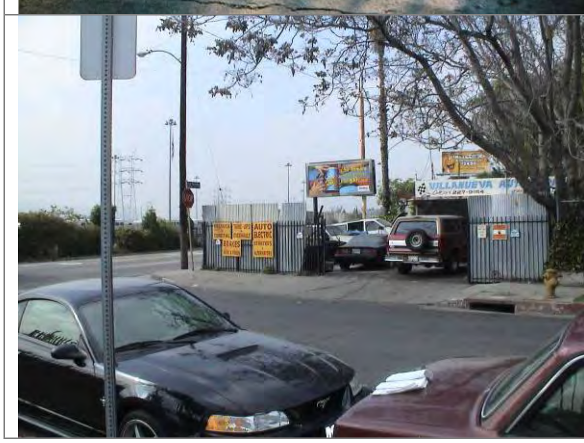
Date inspected:
12/11/03

Comments:
Initial site visit. Top photos are looking upgradient. Auto repair shop across the street; appears to be parking customer's vehicles on street in front off catch basin.

Site : CC-002-C **Location:** McClure and San Fernando Rd., S Corner | Curb-Inlet Basket

Date inspected:
2/4/04

Comments:
This site has high sediment and O&G loads. Oil was flowing in the gutter and into this insert during the visit. The picture on the right was taken a few days after installation.



Date inspected:
3/23/04

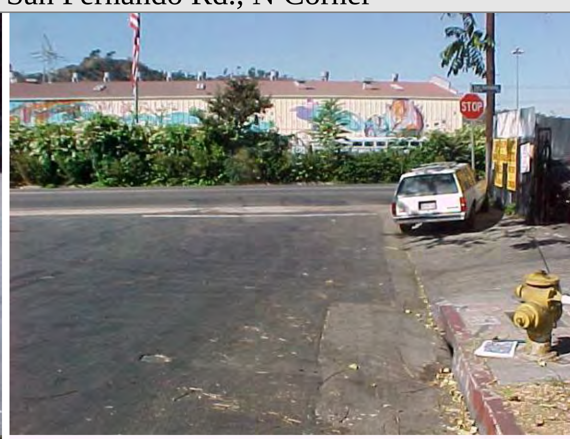
Comments: This insert at this site has collected a lot of sediment and oily residue appears on the absorbent boom and the captured sediment.

Site : CC-002-C **Location:** McClure and San Fernando Rd., S Corner		Curb-Inlet Basket
		
 	 	**Date inspected:** 6/03/04 **Comments:** This insert has recently been cleaned by the LADPW staff. Notice the absorbent boom is no longer present. The media may have been sucked out with a vactor truck.
		**Date inspected:** 10/22/04 **Comments:** This insert was retired after this visit.

Site : CC-002-C **Location:** McClure and San Fernando Rd., S Corner | Curb-Inlet Basket




Site : FL-002-H **Location:** McClure and San Fernando Rd., N Corner | Hydro Kleen


Date inspected:
10/23/03

Comments: Initial site visit. Notice the large amount of leaf matter collected in the catch basin. A car repair shop is located next to this site. Top right picture is looking upstream; top bottom picture. Note that this site was originally a CC site, but was changed to an FL site due to installation timing conflicts.

Site : FL-002-H **Location:** McClure and San Fernando Rd., N Corner	Hydro Kleen
 	**Date inspected:** 2/4/04 **Comments:** First site visit after installation and a single storm event. The insert was installed backwards with the filtration chamber before the sedimentation chamber. The media was placed in the sedimentation chamber, which caused it to float out of the chamber during storm flows. This device was removed from this location during this visit.

APPENDIX C- LABORATORY ANALYTICAL METHODS

C.1 Oil and Grease Analysis

Oil and grease was measured using a solid phase extraction (SPE) technique developed earlier by the authors (Lau and Stenstrom, 1997). This technique uses a known volume of sample (generally 500 ml or 1000 ml for this study) which is pumped through an SPE column at a constant but low rate (e.g., 5 ml/min). The oil and grease in the sample is sorbed on the SPE column. After the sample is pumped through the column, it is eluted with a small volume of solvent (5 ml): methylene chloride and hexane. The sample bottle is also washed with a small volume of solvent (isopropanol). The two solvent volumes are combined and placed in a tarred container. The solvents are allowed to dry at 50°C using a gentle nitrogen purge. The residue is weighed. The results are reported as mg/L based upon the original sample volume. This method is not yet a standard method, but is being developed by the US EPA and others as a standard method. It has the advantages of higher recovery, especially for the more volatile components in oil and grease, and using less solvent (the solvents used for traditional oil and grease analyses are usually flammable, toxic and either green house gases or ozone depleting gases). By using different sample volumes is it possible to have low detection limits, and the limit with 500-ml sample volume is typically 0.25 mg/L. This method does not quantitatively measure oil and grease adsorbed to solids, and an alternate technique must be used for particle-bound oil and grease. However, this is not important for this study because no particles were added to the tap water when testing for oil and grease removal.

C.2 Metal Digestion

Samples for metals analysis were prepared by digesting ~ 0.4 grams of used motor oil in 10 ml concentrated nitric acid for 25 minutes using a microwave unit (CEM Corp., Mathews, NC). This is a modified method from SW Method 3051A (US EPA, 1999). Due to the build-up of high pressure from heated motor oil, a specialized digestion vessel, OMNI™, was used for this purpose. The sample initially was heated to 200°C (in 15 min.) and hold at 200°C for 10 min. After cooling, the digested samples were filtered, diluted to 50 ml and analyzed using a using an inductively coupled plasma-mass spectrophotometer (ICP-MS). Appropriate blanks and standards were used to insure quality control.

FloGard Catch Basin Insert Filter

Inlet Filtration

Removes pollutants from runoff prior to entering waterways

Efficient
catches pollutants where they are easiest to catch, at the inlet.

Variable Design
applications with the ability to be retrofitted or used in new projects.

Treatment Train
can be incorporated as part of a "Treatment Train".

No Standing Water
helps to minimize vector, bacteria and odor problems.

Focused Treatment
removes petroleum hydrocarbons, trash, and TSS.

Maximum Flexibility
available in a variety of standard sizes to fit round and square inlets.

Economical
Receive a higher return on investment.

Two-part insert to filter solids and oil/grease

Easy to install, inspect and maintain, even on small and confined sites

By the Numbers*:

- Filter shall remove 80% of total suspended solids (TSS)
- Capture at least 70% of oil and grease and 40% of total phosphorus (TP) associated with organic debris.

*approx. for urban street application

Catch Basin Filter Test Results Summary

Testing Agency	% TSS Removal	% Oil & Grease Removal	% PAH Removal
UCLA	80	70 to 80	
U of Auckland Tonking & Taylor, Ltd. (for City of Auckland)	78 to 95		
U of Hawaii (for city of Honolulu)	80		20 to 40

Oldcastle Stormwater Solutions™

Multipurpose Catch Basin Insert designed to capture sediment, debris, trash & oils/grease from low (first flush) flows, even during the most extreme weather conditions.

The FloGard® Catch Basin Insert Filters provide solids filtration through a filter screen of filter liner, and hydrocarbon capture shall be effected using a non-leaching absorbent material contained in a pouch or similar removable restraint. They are recommended for areas subject to silt and debris as well as low-to-moderate levels of petroleum hydrocarbons (oils and grease). Examples of such areas are vehicle parking lots, aircraft ramps, truck and bus storage yards, business parks, residential and public streets.

Catch Basin Filter Competitive Feature Comparison

Evaluation of Catch Basin Filters (Based on flow-comparable units) (Scale 1-10)	Oldcastle Stormwater	Other Insert Filter Types**
Flow Rate	10	7
Removal Efficiency*	80%	45%
Capacity - Sludge & Oil	7	7
Service Life	10	3
Installation - Ease of Handling / Installation	8	6
Ease of Inspections & Maintenance	7	7
Value	**10**	**2**

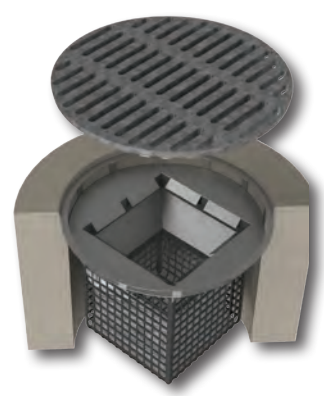
*approximate, based on field sediment removal testing in urban street application **average

Long-Term Value Comparison (Based on flow-comparable units) (Scale 1-10)	Oldcastle Stormwater	Other Insert Filter Types
Unit Value - Initial ($/cfs treated)	10	4
Installation Value ($/cfs treated)	10	7
Absorbant replacement (annual avg ($/cfs treated)	10	2
Materials replacement Value (annual avg ($/cfs treated)	10	10
Maintenance Value (annual avg ($/cfs treated)	10	7
Total first yr ROI ($/cfs treated)	10	5
Total Annual Avg Value ($/cfs treated, avg over 20 yrs)*	**10**	**5**

Combination Inlet

Flat Grated Inlet

Captured debris from the Catch Basin Filter, Dana Point, CA



Circular Frame Catch Basin

Grate Inlet Skimmer Box/Round Curb Inlet Basket - Removal Efficiencies

Numeric Reductions (mg/L)

	Total Suspended Solids mg/L			Total Phosphorus mg/L			Total Nitrogen mg/L		
Location	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency
Site Evaluation - Reedy Creek			74%			57%	24.3	10.4	57%
Creech Engineering Report			73%			79%			79%
Witman's Pond	978	329	66%	18.6	0.452	98%	48.08	9.86	79%
Universal Engineering - 2007 (100 Microns) LATEST REPORT			86%						

	Zinc mg/L			Lead mg/L			Copper mg/L		
Location	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency
UC Irvine						99%			
Longo Toyota	13.7	0.73	95%	1.5	0.2	87%	1.9	0.1	95%

	Ammonia, Salicylate mg/L			Fecal Coliform CFU/100 mL			Cadmium		
Location	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency
Site Evaluation - Reedy Creek	0.38	0.23	39%						
UC Irvine						33%			94%

	Hydrocarbons mg/L		
Location	Inlet	Outlet	Removal Efficiency
UC Irvine			90%
Longo Toyota	199	10.43	95%

Reedy Creek - Site Evaluation of a Grate Inlet Skimmer Box for Debris, Sediment, and Oil & Grease Removal - 1999 - Independent Test
Creech Engineering Report - Pollutant Removal Testing for a Grate Inlet Skimmer Box - 2001
Witman's Pond - Restoration Project - Massachusetts Dept of Environmental Management - 1998 -Independent Test
UC Irvine - Optimization of Stormwater Filtration at the Urban/Watershed Interface - Dept of Environmental Health - 2005 - Independent Test
Longo Toyota - Field Test - City of El Monte - 2002 - Independent Test
Universal Engineering Sciences - Suspended Soils Retention Study - 2007 -Independent Test

Appendix C

Machado Lake Work Plan

City of Torrance, California

MACHADO LAKE NUTRIENT TOTAL MAXIMUM DAILY LOAD

SPECIAL STUDY WORK PLAN

May 18, 2011

3031 Torrance Boulevard • Torrance, California 90503 • Phone: 310.618.5880 • Fax: 310.618.5891

City of Torrance, California

MACHADO LAKE
NUTRIENT TOTAL MAXIMUM DAILY LOAD

SPECIAL STUDY WORK PLAN

May 18, 2011

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City of Torrance, California

SPECIAL STUDY WORK PLAN

1.0 INTRODUCTION

This Field Sampling Plan (FSP) presents the approach and procedures to implement stormwater sampling activities in 2011 for a Special Study of the City of Torrance (City) storm drains discharging stormwater into Machado Lake. The field study sampling procedures, methods, and analyses for stormwater are described in this document.

1.1 Background

The City is subject to the requirements of the Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) Total Maximum Daily Load (TMDL) per the Los Angeles Regional Quality Control Board's (Regional Board's) Resolution R08-006. Under the Regional Board's resolution, the City shall submit to the Regional Board's Executive Officer a Monitoring and Reporting Plan (MRP) within 1 year of the effective date of the resolution or propose a Special Study Work Plan following the requirements of one of three optional studies. This Special Study Work Plan details the approach proposed by the City to perform Optional Study No. 3, to assess compliance with the Waste Load Allocations (WLA) on a mass basis for total nitrogen and total phosphorus originating from the City's watersheds. The Special Study Work Plan proposes a pre-Best Management Practices (BMP) Implementation Study including field sampling and data collection to be followed by submittals to the Regional Board including a BMP Evaluation and Selection Report, a MRP, and a BMP Implementation Report to be provided at a later date.

Machado Lake is identified on the 1998 and 2002 Clean Water Act 300(d) list of impaired water bodies as impaired due to eutrophic conditions, algae, ammonia, and odors. Resource agencies, local governments, project implementers, the scientific community, environmental groups, decision-makers at the city, county, state, and federal levels, and many others have continued to take meaningful steps towards the restoration of Machado Lake and its basin. Among these efforts, restoration activities are expanding through continued implementation of erosion control, stormwater management, and riparian restoration projects, development of the Machado Lake Nutrient TMDL that is providing a quantitative, science-based approach for pollutant reduction, and a strong research/monitoring effort to evaluate key ecological processes and response to water quality improvement projects.

The Machado Lake Nutrient TMDL allows for the establishment of annual mass-based WLAs for total phosphorus (TP) and total nitrogen (TN) equivalent to monthly average concentrations of 0.1 mg/L TP and 1.0 mg/L TN, based on approved flow conditions. When the concentration based WLAs are met under the approved flow condition of 8.45 hm3, the annual mass of the TP discharged to the lake will be 845 kg and the annual mass of TN discharged to the lake will be 8,450 kg. The City of Torrance mass-based WLA will be proportional to the City owned area in the sub-watershed. The City of Torrance area accounts for 35.6% of the Machado Lake Watershed. Table 1 lists the interim and final WLAs based on this area.

Table 1 Waste Load Allocations

Responsible Party	Years after TMDL Effective Date	TP (kg)	TN (kg)
City of Torrance	5	3,760	7,370
	9.5 (final WLAs)	301	3,008

1.2 Site Conditions and Characteristics

1.2.1 Study Site Location

The City is located about 15 miles south of Downtown Los Angeles (LA), in southern LA County, just north of the Palos Verdes Hills. The City was incorporated on May 12, 1921, and is just over 20.5 square miles in area. The City is bounded by Redondo Beach on the west and north, Lawndale and Gardena on the north, LA on the east, Lomita to the southeast, and Rolling Hills Estates and Palos Verdes Estates on the south. The City is also bounded by approximately 4,000 feet of Santa Monica Bay coastline. The City's storm conveyance systems are interconnected with neighboring city systems. Neighboring cities located at generally higher elevation such as Rolling Hills Estate and Palos Verde Estate discharge stormwater into the City's and/or LA County's storm conveyance systems located within the City's boundaries. Figure 1 shows a regional location map of the City.

1.2.2 Hydrology and Hydraulics

The Machado Lake subwatershed is located in the southwestern area of the Dominguez Watershed and includes portions of the Cities of Los Angeles, Torrance, Lomita, Rolling Hills, Rolling Hills Estates, Carson, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, and the communities of unincorporated Los Angeles County, including Wilmington and Harbor City. However, much of the Machado Lake watershed consists of the hilly regions of Rolling Hills Estates and Rolling Hills. This portion of the watershed is unique, as it consists of relatively steep hills with drainage into the canyons. The Machado Lake Watershed covers an area of approximately 20 square miles and is itself divided into six primary subdrainage areas. These subdrainages are the Walteria Lake, Project 77/510, Wilmington Drain, Project 643 (72-inch Storm Drain), Project 643 (Figueroa Drain), and Private Drain 553.

Machado Lake, about 40 acres in area and the Machado Lake Wetlands (64 acres) are located within the Ken Malloy Harbor Regional Park in the southeastern corner of the Machado Lake Watershed. Both Machado Lake and the Machado Lake wetlands serve as flood retention basins for the Machado Lake Watershed.

1.2.2.1 Storm Drain

As the area is highly urbanized, drainage is primarily conducted through an extensive network of underground storm drain facilities. The Los Angeles County Department of Public Works maintains the system of storm drains in the City of Rolling Hills Estates. The primary use of the Dominguez Channel and all other open channels in the Dominguez Watershed (including Wilmington Drain, Machado Lake, and Madrona Marsh) is flood protection.

Machado Lake receives urban and storm water runoff from a complex network of storm drain systems. The first of three primary storm drain channels that flow into Machado Lake is the Wilmington Drain. Approximately 65 percent of the runoff from the Machado Lake Watershed flows through the Wilmington Drain into Machado Lake. The other two primary storm drain channels are the Project No. 77 Drain and the Harbor City Relief Drain. Several smaller storm drains also discharges into Machado Lake, including Project No. 643's Figueroa Street Outlet and a 72-inch storm drain outlet. Machado Lake discharges at the southern end by overflowing a concrete dam into the Machado Lake wetland. Water discharges from the wetland through the Harbor Outflow structure and into the West Basin of the Los Angeles Harbor.

The Walteria Lake, located within the City's boundaries, is owned and operated by LA County. It is approximately 1,005 acre-feet in capacity and receives raw stormwater mainly from Rolling Hills Estates and Palos Verdes Estates. Effluent from the lake is pumped at a maximum rate of 57 cubic feet per second (cfs) through a force main system into a 54-inch drain line that lies under Skypark Drive. The discharge eventually leaves the City near the intersection of Crenshaw Boulevard and Amsler Street.

Figure 2 shows the drainage basins and stormwater conveyance infrastructure in the City. The figure also shows nearby communities discharging stormwater into the City's drainage system.

1.2.3 Land Use

The City of Torrance is predominantly residential land use, with concentrations of industrial and commercial uses. This reflects the City's history as a "company town," where homes were built to house the local work force of industries. Residential development covered almost half of the City's land area. Industrial uses occupied the second largest land area, at 22 percent. Commercial and Public/Quasi-Public/Open Space uses represent the third largest land uses in the City, about 12 percent each. Torrance also had a limited supply of vacant land mostly within commercial and industrial areas. Given the built-out character of the community, only minor land use changes from baseline year 2010 conditions will occur over the long term.

Residential uses are located throughout Torrance at varying development densities. The highest residential densities occur along major streets and near major transportation corridors, in older neighborhoods, and in apartment or condominium developments and Planned Development communities around Sepulveda Boulevard and Plaza Del Amo between Hawthorne and Crenshaw Boulevards. The lowest residential densities are largely located in the western and southern portions of the City. Figure 3 identifies the land uses in Torrance.

1.2.4 Water Quality Issues

Machado Lake, located in the Dominguez Channel watershed in southern LA County, is identified on the 1998 and 2002 Clean Water Act 303(d) list of impaired water bodies as impaired due to eutrophic conditions, algae, ammonia, and odors. The Machado Lake eutrophic, algae, and odor impairments are caused by excessive loading of nutrients, including nitrogen and phosphorus, to Machado Lake (Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) TMDL, Revised Draft – April 2008). Ammonia is found to be at levels below the toxicity standards, but nevertheless, these concentrations contribute to the total nitrogen loading in the Lake. Table 2 provides a summary of the quantifiable loads entering Machado Lake on an annual basis (Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) TMDL, Revised Draft – April 2008). Nutrient flux from the sediments and atmospheric nitrogen deposition are the two directly quantifiable non-point sources included as part of the total nutrient load. The total annual nitrogen and phosphorus loads are estimated to be 24,327 kg and 10,421 kg, respectively.

Machado Lake is located in the Ken Malloy Harbor Regional Park (KMHRP), which is a 231 acres LA City Park serving the Wilmington and Harbor City areas. As shown on Figure 4, the park is located west of the Harbor freeway (110) and east of Vermont Avenue between the Tosco Refinery on the south and the Pacific Coast Highway on the North. Machado Lake is one of the last lake and wetland systems in LA; the area is approximately 103.5 acres in total size. The upper portion, which includes the open water area, is approximately 40 acres and the lower wetland portion is about 63.5 acres. Machado Lake is a shallow polymictic lake; the depth is generally 0.5 to 1.5 meters; the *average* depth is approximately 1.0 meter. The lake was originally developed as part of Harbor Regional Park in 1971 and intended for boating and fishing. Over the years water quality generally declined; boating was stopped and signs were posted warning of the risk of eating fish from the lake.

Table 2 Total Annual Nutrient Load Entering Machado Lake(1)

Source	Total N (kg)	Total P (kg)	Ortho-P (kg)	Inorg-N (kg)
External Load	7,587	3,260	737	3,736
Sediment Flux	16,520	7,161	4,963	16,520
Atmospheric Deposition	220			
Total Annual Load	**24,327**	**10,421**	**5,700**	**20,256**

Notes:
1. Source: Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) TMDL, Revised Draft - April 2008.

The dominant land use in the Machado Lake Watershed is high-density single-family residential, accounting for approximately 45 percent of the land use. Industrial, vacant, retail/commercial, multi-family residential, transportation, and educational institutions each account for 5 to 7 percent of the land use, while "all other" accounts for the remaining 23 percent. Machado Lake is a receiving body of urban and stormwater runoff from a network of storm drains throughout the watershed. As indicated on Figure 4, there are three discharge points into Machado Lake from the following storm drain channels:

- Wilmington Drain.
- Project No. 77.
- Harbor City Relief Drain.

Approximately 88 percent of the Machado Lake Watershed drainage area flows through the Wilmington Drain into Machado Lake.

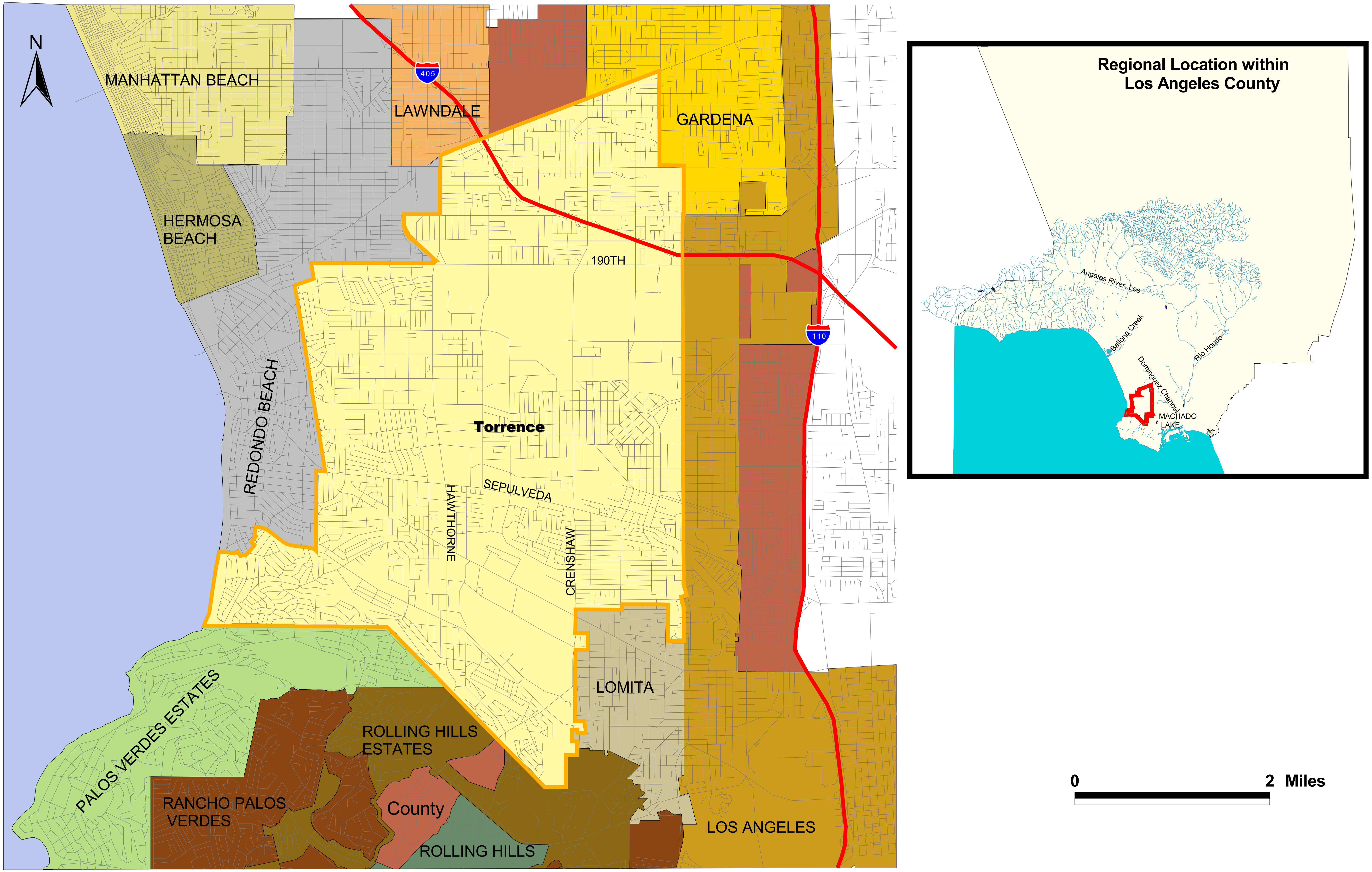


Figure 1 Regional Map of Torrance

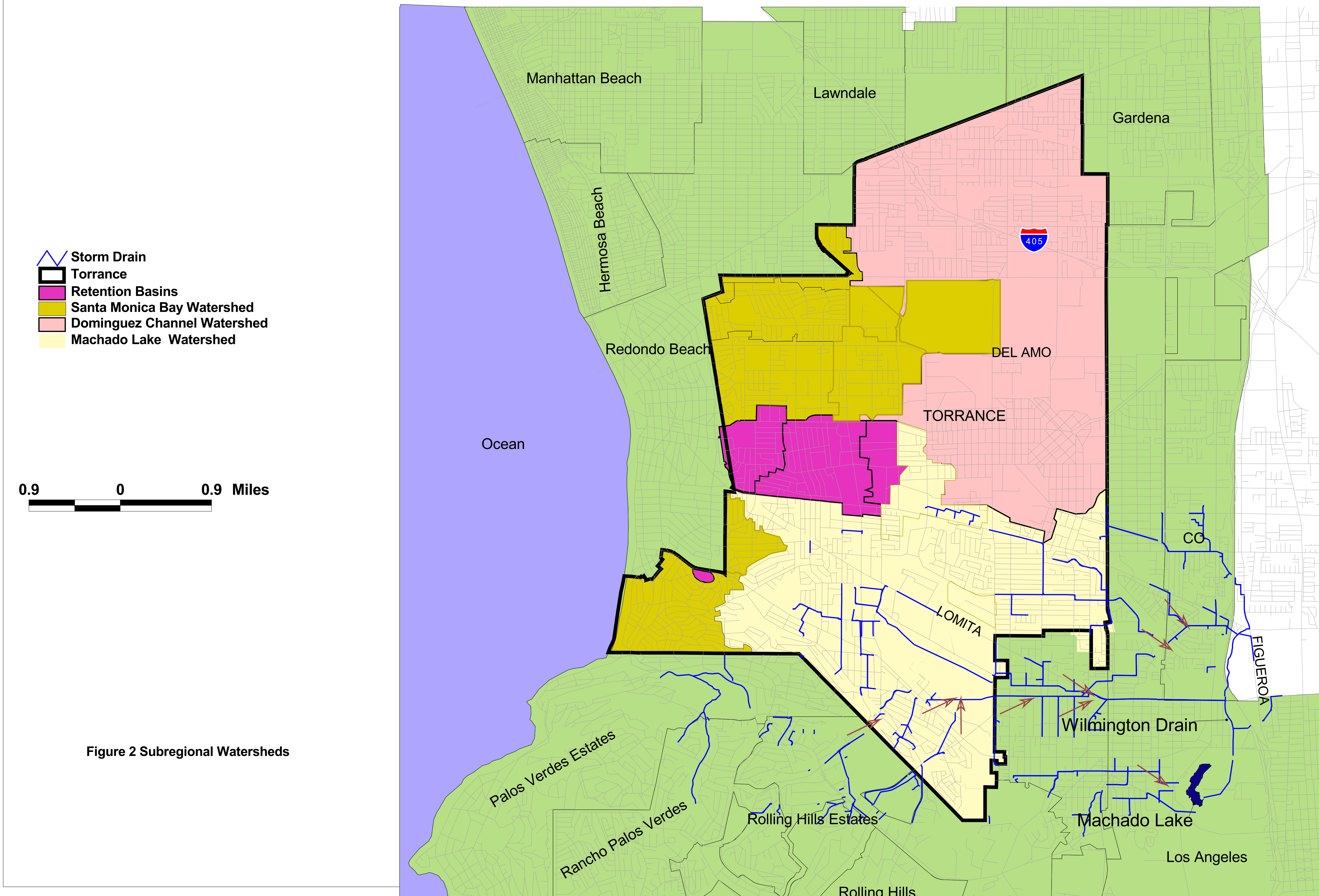


Figure 2 Subregional Watersheds

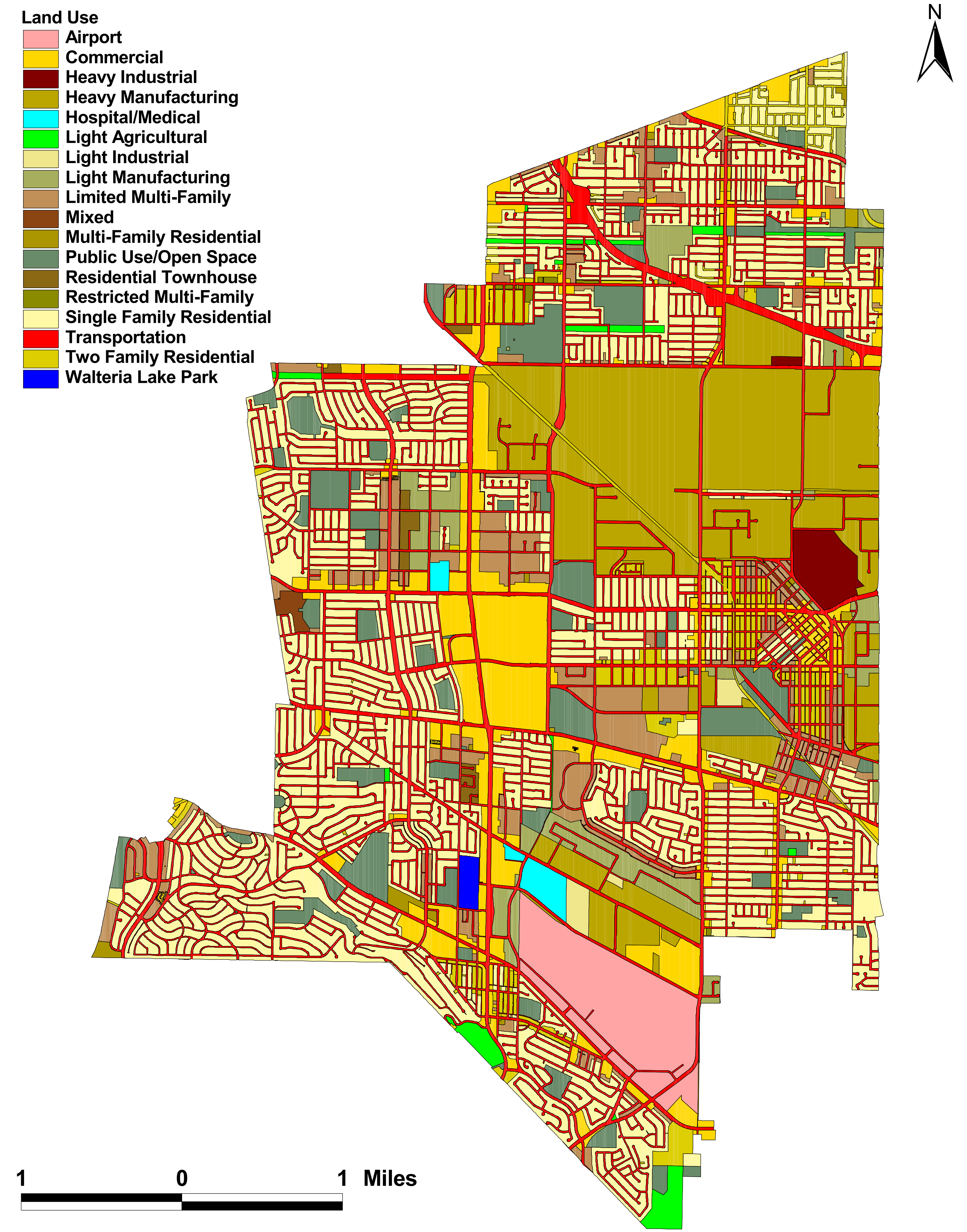


Figure 3 Existing Land Use of Torrance

Figure 4 2007 Satellite Imagery of Machado Lake and Ken Malloy Harbor Park Overview

1.3 Special Study Work Plan

This document provides the overall structure of the Special Study Work Plan with submittals to the Regional Board, as well as providing the initial Pre-BMP Implementation Study Plan (including a proposed field data collection and sampling plan). The Special Study Work Plan addresses the requirements of Optional Study No. 3 to assess compliance with WLAs for total nitrogen and total phosphorus originating from the City's watersheds. The scope of work for this plan includes the following:

- Pre-BMP Implementation Study Period - Including conducting dry weather sampling as outlined within this submittal as well as reviewing water quality models developed by LA County for wet weather events and Machado Lake.
- BMP Evaluation and Selection Study Report - This study report is to be submitted at a later date (see proposed schedule of work plan elements), and will summarize the collected field data and the applicable results obtained from the regional water quality model being developed by LA County for wet weather conditions. The field data and the water quality model data will be used to assess compliance with WLAs under the TMDL. Based on the assessment of compliance, the BMP and Selection Study Report will identify and screen structural BMPs for mitigation to bring the City into compliance with the TMDL.
- Monitoring and Reporting Plan - Subsequent to acceptance by the Regional Board of the findings and conclusions of the City's BMP Evaluation and Selection Study Report, the City will submit an MRP specific to the needs for assessment of future compliance with the TMDL.
- BMP Implementation Report - This report will summarize the monitoring data collected after 12 months of BMP implementation and will provide to the Regional Board an assessment of the success of the structural BMPs implemented by the City to support compliance with the TMDL.

The actual start date for the sampling will be determined following the Regional Board's approval of this Special Study Work Plan. Other conditions that may affect the sampling schedule are weather and equipment conditions and availability. The schedule for the work plan is summarized in Table 3.

The Special Study Work Plan identifies the proposed tasks the City agrees to perform, their timelines, and the roles and responsibilities of various parties in completing the work. The purpose of this document is to serve as a starting point for work planning discussions between the City and the Regional Board.

Table 3 Schedule or Work Plan Elements

ID	Work Plan Element	Schedule
1	Special Study Work Plan	May, 2011 (submittal)
2	Regional Board Review/Approval	June, 2011 (approval)
3	Pre-BMP Implementation Study	July, 2011 – July, 2012 (field sampling)
4	BMP Evaluation, Monitoring and Reporting Plan	September, 2011 (submittal)
5	Regional Review/Approval	August, 2012 (approval)
6	BMP Implementation	Nov., 2012 (implementation)
7	BMP Implementation Report	Nov., 2013 (submittal)

2.0 PRE-BMP IMPLEMENTATION STUDY

2.1 Introduction

The Pre-BMP Implementation Study includes a 12-month FSP and evaluation of regional water quality models for wet weather conditions and Machado Lake to assess the City's current compliance with WLAs. The FSP covers sample collection methods, analytical procedures, data analysis and reporting, and health and safety aspects. The FSP will generate a variety of data including discharge rates and flow volumes, the concentrations of chemical parameters, and the measurement of physical parameters. Utilizing the mass balance approach, the data will be used to estimate the mass of nutrients originating from the City as well as nearby agencies discharging stormwater into the City's storm drain system. The data will also be examined for patterns and trends, comparing stormwater quality between different sampling locations over time.

The Pre-BMP Implementation Study will be undertaken once approval is obtained from the Regional Board for the Special Study Work Plan.

The remaining sections of this document contain the FSP providing field sampling methods and analytical procedures that will be used to collect dry weather water quality data and continuous flow data.

2.2 Objectives of the Pre-BMP Implementation Study

The Pre-BMP Implementation Study will provide the City data needed to assess water quality impacts to the City's drainage network. The objective of this study is to support the City's compliance with the Machado Lake Nutrient TMDL by performing Special Study No. 3. Data and information elements that are part of the Pre-BMP Implementation Study include:

1. Dry weather flow data including calculation of continuous volume data and water quality data obtained through field monitoring and sampling (data to be collected by implementing the FSP included within this document).

2. Estimates of wet weather stormwater quality impacts identified using an integrated water quality model developed by the City of Torrance. The water quality model is described in Section 2.2.1.
3. Identification of BMPs that will be implemented by the City to mitigate observed water quality impacts in the City's outflows to Machado Lake.

2.2.1 Pollutant Loading and Analysis Tool (PLAT)

In order to estimate wet weather stormwater quality impacts, the City has developed an integrated watershed modeling tool to simulate watershed hydrology, nutrient, sediment, and contaminant dynamics. This tool called Pollutant Loading and Analysis Tool (PLAT), incorporates existing and commonly used watershed models. The main models used by PLAT are PLOAD, Program for Predicting Polluting Particle Passage thru Pits, Puddles, and Ponds (P8), and U.S EPA SUSTAIN model. PLAT is based on spatially distributed inputs derived from high resolution satellite imagery. PLAT has four main components: pollutant hot-spots characterization, BMP screening, continuous simulation, and BMP design, optimization, and placement. The SUSTAIN model provides an optimization routine that helps identify the appropriate size of BMPs for treating stormwater runoff from respective source areas to meet TMDL reduction goals. The tool has been validated with results from the LA County Watershed Management Model System (WMMS).

3.0 FIELD SAMPLING PLAN

The 12-month FSP is designed to collect continuous flow data and discrete dry weather water quality data to support the overall study objectives summarized in Section 2.

3.1 Sampling Locations and Access

Site selection is a major challenge, given the scarcity of funding for sampling and laboratory analysis. The number of locations to be sampled was decided based on the program objectives, regulatory requirements, and the size and complexity of the drainage sub-basins and conveyance system. In addition, the frequency of sampling at each location was considered.

As a first step in the selection process, the City's watersheds, sub-basins and drainage system network were reviewed. Based on this review, nine locations were identified that could be used to characterize the flows in and out of each subbasin. Four of these locations are needed at a minimum to characterize the flows conveyed to Machado Lake. The final selection of sample locations was based on factors such as site permission, access, clustering, personal safety, equipment safety, and the likelihood that stormwater would flow at the location. Table 4 summarizes the proposed stormwater sampling locations, types, and characteristics. The general sampling locations are depicted on Figure 5. Appendix A shows detailed characteristics of each sampling location.

At a minimum, four sampling locations will meet the objectives of this program. However, the City will sample five additional locations, Tor-S3, Tor-S6, Tor-S7, Tor-S8, and Tor-S9 as shown on Figure 4 because the results will support critical decisions including identifying sources originating outside of the City's boundaries or sources not under the direct control of the City. The sampling locations Tor-S6, Tor-S7, Tor-S8, and Tor-S9 are discharge points for Rolling Hills and Palos Verdes Estates.

The sampling locations are described below.

Tor-S1

This site is located 40 ft north and 80 ft east of the intersection of Plaza Del Amo and Western Avenue. The total upstream drainage area is approximately 63 acres. The drainage area is mainly residential and commercial land use. Residential and commercial land uses represent 36 percent and 33 percent, respectively, of the drainage area. This site is easily accessible and safe for conducting sampling during both dry and wet weather conditions. The storm sewer conveying stormwater to this site is a 36-inch reinforced concrete pipe. This site is one of the four sites that will provide information on the amount of pollutants leaving the City limits.

Sampling Site: TOR-S1

Table 4 Sampling Location Characteristics

Sampling Location Name	Description	Land Use	GPS Coordinates	Associated Upstream Storm Drain Name	Diameter (in) and Material
Tor-S1	Located 40 ft north and 80 ft east of the intersection of Plaza Del Amo and Western Avenue. .	Residential/ commercial	33° 49.3572' 118° 18.5208'	City	36 RCP
Tor-S2	Approximately 50 ft west of 246th Place and Pennsylvania Avenue intersection.	Mixed	33°48.093' 118° 19.5252'	City	33 RCP
Tor-S3	Effluent of Walteria Lake, approximately 100 ft east of Madison St. and Skypark Drive intersection.	Mixed	33°48.6312 118° 20.8674'	Walteria Lake	54
Tor-S4	Approximately 210 ft north and 85 ft east of 236th Street and Western Avenue intersection.	Mostly residential	33° 48.7056' 118° 18.5196'	City	9'-2"Wx11'H RCB
Tor-S5	About 25 ft west of intersection of Bani Avenue and 250th Street (two pipes intersect from south and west).	Residential/ Airport	33° 47.8956' 118° 19.6872'	City	8'-9"Wx9'-7"H RCB
Tor-S6	Approximately 600 ft east of Estates Lane and Crenshaw Boulevard.	Mostly residential	33° 47.1822' 118° 20.43'	Rolling Hills Estates	36 RCP
Tor-S7	About 160 ft south and 280 ft east of Rolling Hills Road and Hawthorne Blvd. intersection. Will monitor dry weather flow originating from Rolling Hills Estates.	Mostly residential	33° 47.6826 118° 20.9232'	Rolling Hills Estates	10'x10' RCB
Tor-S8	About 500 ft northwest of Paseo De Las Tortugas and Mesa St. intersection. Will monitor dry weather flow originating from Rolling Hills Estates.	Mostly residential	33° 48.0522' 118° 21.4254'	Rolling Hills Estates	24 RCP
Tor-S9	About 830 ft east and 120 ft south of Paseo de las Tortugas and Vista Montana intersection. Will monitor dry weather flow originating from Palos Verdes Estates.	Mostly residential	33° 48.2742' 118° 21.7776'	Palos Verdes Estates	42 RCP

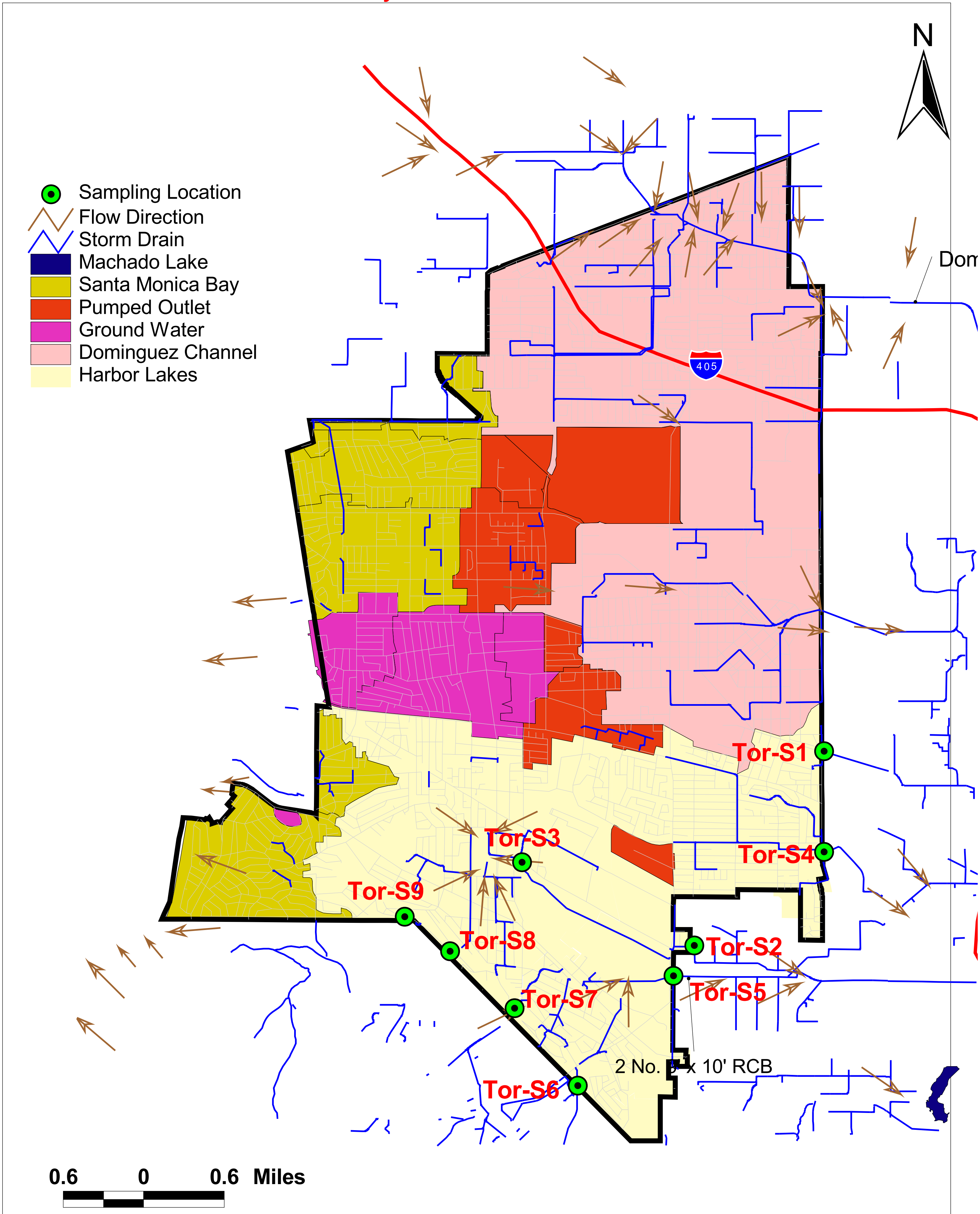


Figure 5 General Location Map of Sampling Locations

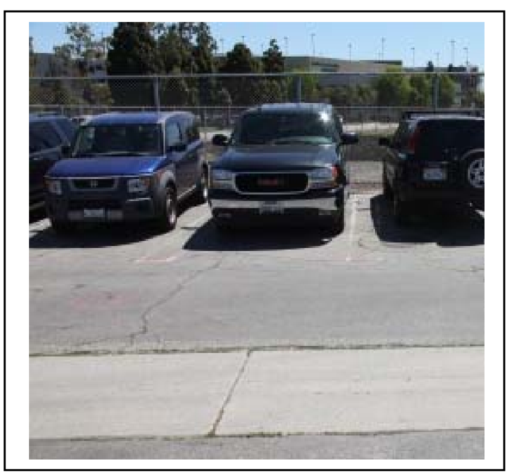
Tor-S2

Tor-S2 is approximately 50 ft west of the intersection of 246th Place and Pennsylvania Avenue. The total upstream drainage area is about 2,605 acres. The drainage area is a mixed land use, about 32 percent residential, 10 percent commercial and 11 percent industrial. The Torrance Airport accounts for 12 percent of the drainage area. Tor-S2 is easily accessible and safe for conducting sampling during both dry and wet weather conditions. Stormwater is conveyed to this site through an 8' x 7' reinforced concrete box. This site is one the four sites that will provide information to quantify the amount of pollutants leaving the City limits.


Sampling Site: TOR-S2

Tor-S3

This site, which is approximately 100 ft east of Madison St. and Skypark Drive intersection, will assist the City in characterizing discharges from Walteria Lake. The total upstream drainage area is approximately 2,285 acres. This site is upstream of Tor-S2. Land use is mixed with 37 percent residential, 10 percent commercial and 9 percent industrial. A 54-inch pipe conveys stormwater to this site. The site is easily accessible and safe for all weather sampling.




Sampling Site: TOR-S3

Tor-S4

Tor-S4 is approximately 210 ft north and 85 ft east of 236th Street and Western Avenue intersection. The total drainage area upstream of this sampling location is approximately 1,014 acres. Residential land use represents nearly 60 percent of the drainage area. Commercial and industrial land uses represent only 9 percent of the drainage area. The storm drain serving this site is a 9’-2” x 11’ RCB. The site is safe for all weather sampling and it is easily accessible.

Sampling Site: TOR-S4

Tor-S5

This site is about 25 ft west of the intersection of Bani Avenue and 250th Street (two pipes intersect from south and west). This sampling site serves an upstream drainage area of approximately 661 acres. This site is mainly residential and airport land use; residential and airport land uses represent 43 and 24 percent of the drainage area, respectively. The storm drain discharging stormwater to this site is an 8’-9” x 9’-7’ RCB. This site is easily accessible and safe for sampling activities.

Sampling Site: TOR-S5

Tor-S6

Tor-S6 is located at approximately 600 ft east of Estates Lane and Crenshaw Boulevard. This site will monitor flow entering the City's storm drain from Rolling Hills Estate. The sampling site is safe and easily accessible.

Sampling Site: TOR-S6

Tor-S7

This site is about 160 ft south and 280 ft east of Rolling Hills Road and Hawthorne Blvd. intersection. It will monitor dry weather flow originating from Rolling Hills Estates. The site is easily accessible and safe for sampling at all weather conditions.

Sampling Site: TOR-S7

Tor-S8

This site is located at about 500 ft northwest of Paseo De Las Tortugas and Mesa St. intersection. It will monitor dry weather flow originating from Rolling Hills Estates. The site is easily accessible and safe for sampling at all weather conditions.

Sampling Site: TOR-S8

Tor-S9

Tor-S9 is about 830 ft east and 120 ft south of Paseo de Las Tortugas and Vista Montana intersection. This site will monitor dry weather flow originating from Palos Verdes Estates. The site is accessible and safe for sampling activities.


Sampling Site: TOR-S9

3.2 Sample Collection Frequency

The City's sampling program consists of three major elements:

1. Monthly sampling during dry weather conditions for all sampling locations. Grab samples will be collected from each sampling location. Dry weather conditions must be preceded by at least 24 hours of no greater than trace precipitation or have an intensity of less than 0.1 inches of rain in a 24-hour period.

2. Samples will be collected from Tor-S3 during four discrete storm events and anytime time the LA County pumps stormwater from the Walteria Lake into the 54-inch storm drain. Pumping schedule will be obtained from LA County.

3. Continuous recording of stage or flow depth during dry weather periods for flow estimation will be collected from the proposed sample locations during dry weather flow conditions.

Regarding Tor-S3, one grab sample for each of the four storm events will be collected under the following conditions:

1. Sampling will occur during a storm event with at least 0.1 inch of precipitation (defined as a "measurable" event). Weather forecasts will be evaluated before deciding whether or not to sample a particular rain event. The monitoring manager will periodically establish a modem connection with each sampling unit to monitor rainfall, flow rates, and sampling activity. The monitoring manager will download stored data from the National Weather Service as needed.
2. Sampling will not occur at a frequency greater than once every 72 hours.
3. Sampling will not occur unless there has been at least 72 hours of continuous dry weather immediately preceding the "measurable" event.
4. Grab samples will be collected from this location during approximately the first 30 minutes to 1 hour of stormwater discharge (where possible).

The intention of the sample collection frequency and stormwater event requirements described above is to collect samples that are representative of runoff conditions from Tor-S3. No samples will be collected from the remaining eight sampling locations during storm events. The City's Pollutant Loading and Analysis Tool (PLAT) will be used to estimate nutrient loading for these sampling location during storm events.

3.3 Selection of Analytical Parameters

The City proposes to use a mass based WLA compliance option to evaluate TMDL compliance. Samples submitted for nutrients will be tested for ammonia-N (NH_3^+), ammonium, nitrite (NO_2), nitrate (NO_3), total Kjeldahl nitrogen (TKN), total phosphorus (TP), and phosphate (PO_4). Water samples submitted for conventional water parameters (general chemistry) will be tested for alkalinity, pH, chloride, total suspended solids (TSS), total solids, dissolved solids, turbidity, dissolved organic carbon (DOC), total organic carbon (TOC), and standard metals. The constituents to be sampled are listed in Table 5.

Table 5 Monitoring Constituents

Analyte	Method of Analysis	Detection Limits
NH_3^+	SM 4500-NH_3-H	0.02 mg/l
NO_3	SM 4500-NO_3-F	0.02 mg/l
NO_2	SM 4500-NO_3-F	0.01 mg/l
TKN	EPA 351.3	0.1 mg/l
TP	EPA 365.4	0.06 mg/l
PO_4	SM 4500-P-F	0.01 mg/l
TSS	EPA 160.2	0.5 mg/l
Turbidity	n/a	0.01 NTU

3.4 Continuous Flow Monitoring

Accurate assessment of flow is crucial to pollutant loads assessments and analysis. Continuous flow data will be collected as part of this sampling effort for all nine sampling locations. The primary benefit of these continuous monitoring sites is the ability to gauge the increase in flow due to a storm event and apply concentration data to calculate pollutant loading.

Global Water's FL16 Water Flow Logger will be used for flow data collection. The FL16 Water Flow Loggers will record over 81,000 depth, temperature, water flow and velocity readings in the drainage pipes. The specially engineered, non-fouling water level sensor works in depths as little as ½ inch and allows for deployment in manholes and other difficult to access areas without the need to enter the confined space.

FL16 Water Flow Recorder's user-friendly Windows-based software is tailored specifically for calculating water flows in partially filled sewer and drainage pipes using the Manning's Equation, with pull-down menus for selecting and entering the necessary information. The Water Flow Recorder software has a unique calibration feature which allows users to view calculated water velocity, compare this to actual measured data, and adjust the water flow parameters to calibrate for the water flow conditions of a specific application.

The flow measuring systems will be calibrated before data collection begins and that these will be re-calibrated monthly.

3.5 The Sampling Team

Grab samples from the nine sampling locations will be collected by a contract lab retained by the City. Pre-labeled sample bottles will be provided by the certified laboratory that will be conducting the analyses. The Sampling Team will be responsible for ensuring that all required equipment is ready for field operation. They are also responsible for performing the entire field sampling activities and most of the sampling preparation. Any member of the Sampling Team may recommend canceling sampling if the predicted conditions do not materialize or if health or safety of the team could be imperiled due to site conditions or extreme weather.

4.0 SAMPLE COLLECTION PROCEDURES

This section describes the sampling procedures, record keeping, sample handling, storage, and field quality control procedures that will be used during stormwater sampling.

4.1 Preparation for conducting the sampling

Several things will be done to prepare to conduct stormwater sampling. First, the laboratory to analyze the samples will be contacted. The following information will be sought from the lab:

- Type and size of bottles needed
- Procedures to filling the bottles
- Sample volume requirements
- Labels or additional forms required
- Explanation of the chain of custody form
- Sample preservation requirements and/or holding time restrictions
- Means of sample delivery to the lab
- Overnight delivery requirements
- Costs

Once a lab has been selected the sampling equipment (sampling bottles from a lab, sampling instruments, and personal safety equipment) will be made ready, as well as the field sheet to document the required information. Table 6 lists constituents and sample container requirements.

Field personnel will complete a field condition data sheet. The following items will be listed on the field sampling sheet and included in the stormwater discharge monitoring report:

- Person who conducted the sampling
- Date and time of discharge
- Length of storm event
- Time between sampled storm event and previous storm event (at least 72 hrs)
- Total rainfall during storm event
- Photo documentation

A field data sheet is attached as Appendix B.

4.1.1 Sampling Equipment

Monitoring equipment will be gathered ahead of time because opportunities to sample during rainfall events often come with little advanced notice. The following equipments will be required for the sampling efforts:

- Field forms
- Waterproof pens
- Permanent markers

- Powder-free nitrile gloves
- Clear glass jar for visual examinations
- Sample containers
- Sample preservatives
- Sample container labels
- COC forms
- COC seals
- Ice chests
- Ice
- Foul-weather gear
- Manhole sampler

Table 6 Monitoring Constituents and Sample Container Requirements

Analyte	Container	Volume	Preservation	Holding Time
NH_3^+	Plastic	50 ml	≤ 6°C H2SO4 PH < 2	28 days
NO_3	Plastic	50 ml	≤ 6°C, H2SO4 PH <2	48 hours
NO_2	Plastic	50 ml	≤ 6°C, H2SO4 PH <2	48 hours
TKN	Plastic	50 ml	≤ 6°C, H2SO4 PH <2	28 days
TP	Plastic	50 ml	≤ 6°C, H2SO4 PH <2	28 days
PO_4	Plastic	50 ml	≤ 6°C	48 hours
TSS	Plastic	200 ml	≤ 6°C	7 days

4.2 Sampling Method

Water samples will be collected from storm sewer manhole and outfall sites. All samples will be collected as individual grabs. Samples will be collected directly into sample containers or with a laboratory-supplied container attached to a pole with duct tape or other means. Sampling containers will be held with container openings facing upstream to prevent contamination during sampling. Field personnel will wear powder-free nitrile disposable gloves. Each sample will be given a field identification, tagged, and kept cool at 4 degrees C. Chain-of-custody (COC) procedures will be observed and samples delivered to the laboratory within the allowable holding times for each parameter.

It is assumed that sampling locations will have well-mixed conditions so that single grabs are representative of water quality. Field personnel will record the degree of turbulence or quiescence as well as the dimensions of the conveyance sampled and/or a description of water flowing in the conveyance. Field personnel will also record the date and time of sample collection and the flow rate.

Sampling containers for direct grabs (either by hand or with pole attached to laboratory supplied container) will be pre-cleaned by the laboratory. It will be made certain that if a sample is transferred (either for collection purposes or to form grab-composite samples), that only laboratory-supplied containers are permitted to come in contact with the sample.

4.3 Personal Safety

A Health and Safety Plan approved by the contract lab will be reviewed by the all field personnel before the sampling operations covered in this monitoring plan begin. Personal safety will be of primary concern while conducting all stormwater sampling related activities. All persons involved in the sampling operation will be made aware of the hazards associated with monitoring and should freely voice any concerns if potential hazards become apparent. The Occupational Safety and Health Administration (OSHA) provides regulations and guidance on occupational safety, many of which are directly applicable to the types of activities involved in stormwater monitoring. It is the direct responsibility of each person involved in the monitoring program to read the Health and Safety Plan and adhere to its requirements. The following list provides a few basic health and safety procedures that will help to create a safer sampling environment.

- Do not sample alone, a minimum of two-person field crews will be used for stormwater sampling.
- Do not enter a confined space without proper training, equipment, and surface support.
- Never remove or replace manhole covers with your bare hands or feet.
- Never leave an open manhole unattended.
- Do not start staging or sampling until traffic control has been established.

4.4 Clean Sampling Techniques

Clean sample collection techniques will be followed to minimize the potential for contamination of stormwater runoff samples. Care will be taken during all sampling operations to avoid contamination of the water samples by human, atmospheric, or other potential sources of contamination. The monitoring team should prevent contamination of any of the following items: composite bottles, lids, sample, tubing, and strainers.

4.5 Sample Packing and Shipping

Monitoring personnel will deliver the samples to the laboratory. Sample bottles will be placed in coolers or some other package that is rigid enough to provide protection of the samples and is insulated to keep samples cold. During packing, the sample from one monitoring location will not be separated into separate shipping containers unless bottles of one size need to be shipped together because of container size. If samples from a location are separated a copy of the field-sampling sheet pertaining to the bottles will be enclosed in each shipping container. Prior to shipping, all sample bottles will be recorded on the packing lists, which will include the shipping date and the method of transporting the samples. Samples will be delivered to the analytical laboratory within 4 hours of sampling to ensure the maximum holding time for bacteria of 6 hours is not exceeded.

4.6 Chain of Custody

After samples have been obtained and the collection procedures properly documented, a written record of the COC of each sample will be made. This record ensures that samples will not be tampered with or inadvertently compromised in any way, and it also tracks the requested analysis for the analytical laboratory. COC refers to the documented account of changes in possession that occur for samples.

The COC record tracks the sampling path from origin through laboratory analysis. Information necessary in the COC includes:

- Name of the persons collecting the sample(s).
- Date and time of sample collection.
- Location of sample collection.
- Names and signatures of all persons handling the samples in the field and in the laboratory.
- Laboratory analysis requested and control information (e.g., duplicate or spiked samples etc.) and any special instructions (e.g., time sensitive analyses).

To ensure that all necessary information is documented a COC form will accompany each sample or set of samples. COC forms will be printed on multipart carbonless paper so that all personnel handling the samples may obtain a copy. A COC record should accompany all sample shipments and the sample originator will retain a copy of the forms. When transferring custody of samples the transferee will sign and record the date and time of each transfer. Each person who takes custody will complete the appropriate portion of the chain of custody documentation. A sample COC form to be used for this field sampling is attached as Appendix C.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

5.1 Data Quality Objective

The quality assurance/quality control (QA/QC) program will be implemented to satisfy the data quality objectives of the monitoring program. The primary data quality objectives are to obtain defensible data of acceptable sensitivity and quality to:

- Evaluate the stormwater management program.
- Evaluate stormwater quality.
- Evaluate of BMP as corrective measure.

The analytical laboratory selected for this study will evaluate the accuracy of its sample extraction and/or analytical procedures using spiked samples, which may include matrix spikes (MS), laboratory control samples (LCS) and surrogate spikes. Acceptable spike recoveries must fall within statistically derived laboratory "control limits." Precision is the agreement among a set a replicate measurements of the same parameter. The analytical laboratory will evaluate precision by performing matrix spike duplicate (MSD), laboratory control sample duplicate (LCSD) and duplicate stormwater sample analyses (typically performed for inorganic parameters only). The data quality objectives also include obtaining data that are comparable and representative of the water quality conditions at each monitoring location. Comparable data will be collected if comparable sampling, analysis, QA/QC and reporting procedures are implemented throughout the monitoring program. Representative samples will be collected by performing sampling activities compliant with the procedures described in this monitoring plan. Duplicate samples will be collected and the results will be used to evaluate representativeness. Comparability expresses the confidence with which one data set can be compared to another. Data are comparable if collection techniques, measurement procedures, methods, and reporting are equivalent for the samples within a sample set. Data quality assurance objectives are summarized in Table 7.

Table 7 Quality Assurance Objective

Analyte	Units	Precision	Accuracy	Reporting Limit	Completeness
NH_3^+	mg/l	±20%	±30%	0.10 mg/l	90%
NO_3	mg/l	±20%	±30%	0.1 mg/l	90%
NO_2	mg/l	±20%	±30%	0.1 mg/l	90%
TKN	mg/l	±20%	±30%	0.1 mg/l	90%
TP	mg/l	±20%	±30%	0.1 mg/l	90%
PO_4	mg/l	±20%	±30%	0.025 mg/l	90%
TSS	mg/l	±20%	±30%	1 mg/l	90%

5.1.1 Field Quality Control Samples

Field quality control samples will be collected at a 10% frequency in order to provide quality performance information for the sampling program. One in ten samples submitted for analysis will be one of three field QC sample types: field blank; field duplicate; and/or performance evaluation blank. Table 8 lists the quality performance goals that each of the three types of field QC sample types is intended to address.

Table 8 Field Quality Control Sample Types

Quality Performance Goal	Field Blank	Field Duplicate	Performance Evaluation Blank
Minimize false positive results	X		X
Sample bottles free of contamination	X		
No contamination introduced by sampling process	X		
Measurement error attributable to sample inhomogeneity		X	

5.2 Field Quality Assurance/Quality Control

This section summarizes the QA/QC procedures that will be implemented by field personnel to evaluate sample contamination, sampling precision, and matrix interference.

5.2.1 Equipment Blanks

After the intermediate sample container or scoop is cleaned, an equipment blank will be collected by pouring reagent-grade water into the apparatus. The water will be transferred into sample bottles and analyzed for the full analytical suite.

5.2.2 Field Duplicate Samples

Field duplicate samples will be collected to evaluate the precision and representativeness of the sample collection procedures as well as sample homogeneity. The duplicate sample will be collected using the specified manual grab sampling techniques. Twice the volume required for the analytical suite will be collected with each duplicate sample. For grab samples, intermediate sample containers will be used, and the volume collected will be apportioned equally between the intermediate containers. The water in each intermediate container will be poured into a discrete set of sample bottles. One set of bottles will be labeled with fictitious sample identification and submitted “blind” to the laboratory.

5.2.3 Matrix Spike Samples

MS and MSD analyses will be performed by the laboratory using project samples. Field crews will submit twice the required sample volume for the sample selected as the matrix spike sample. Field personnel will identify the MS/MSD sample on the COC form.

5.3 Laboratory Quality Control

This sub-section summarizes the QC procedures the laboratory will perform and report with the analytical data packages. These procedures are not inclusive of the QA/QC that is required for compliance with the analytical method.

5.3.1 Method Blanks

A method blank is prepared using reagent-grade water, and is extracted and analyzed with each sample batch (typically 20 samples extracted and/or analyzed on a given day). Method blank results are used to identify potential sources of sample contamination resulting from laboratory procedures. Target analytes should not be detected in the method blank above the practical quantitative limit.

5.3.2 Matrix Spike and Laboratory Control Samples

MS, MSDs, LCS, and LCSDs will be performed by the laboratory to evaluate the accuracy of the sample extraction and analysis procedures. MS/MSDs will also be performed to evaluate matrix interference. Matrix interference is the effect of the sample matrix on the analysis, which may partially or completely mask the response of the analytical instrumentation to the target analyte(s). Matrix interference may affect the accuracy of the extraction and/or analysis procedures to varying degrees, and may bias the sample results high or low. The

MS/MSD is prepared by adding known quantities of target analytes to a sample. The sample is then extracted and/or analyzed as a typical environmental sample, and the results are reported as percent recovery.

6.0 DATA MANAGEMENT AND REPORTING

The sampling results will be reported by the laboratory as hard copy and as electronic files. Hard copy data will be entered into an electronic format, and checked at least once by a different person. Electronic submittal of results will be discussed with the analytical laboratory in advance of delivery and its format arranged. A separate record will be generated for each sample analysis.

In addition, the key information such as station ID, sample date and time, name of sampler, name of constituent, all results, units, detection limits, methods used, name of the laboratory, and any field notes will be entered into the database. Additional information, such as compositing of multiple samples, or the use of grab will also be included.

When reporting the laboratory results for each stormwater sample the following information will be provided:

- Sample site.
- Sample date and time.
- Sample number (or identification).
- Sampling technician(s).
- Detection limit and reliability limit of analytical procedure(s).
- Sample results with clearly specified units.

The results of all samples collected under this plan will be submitted to Regional Board in a monitoring report. Monitoring report will include:

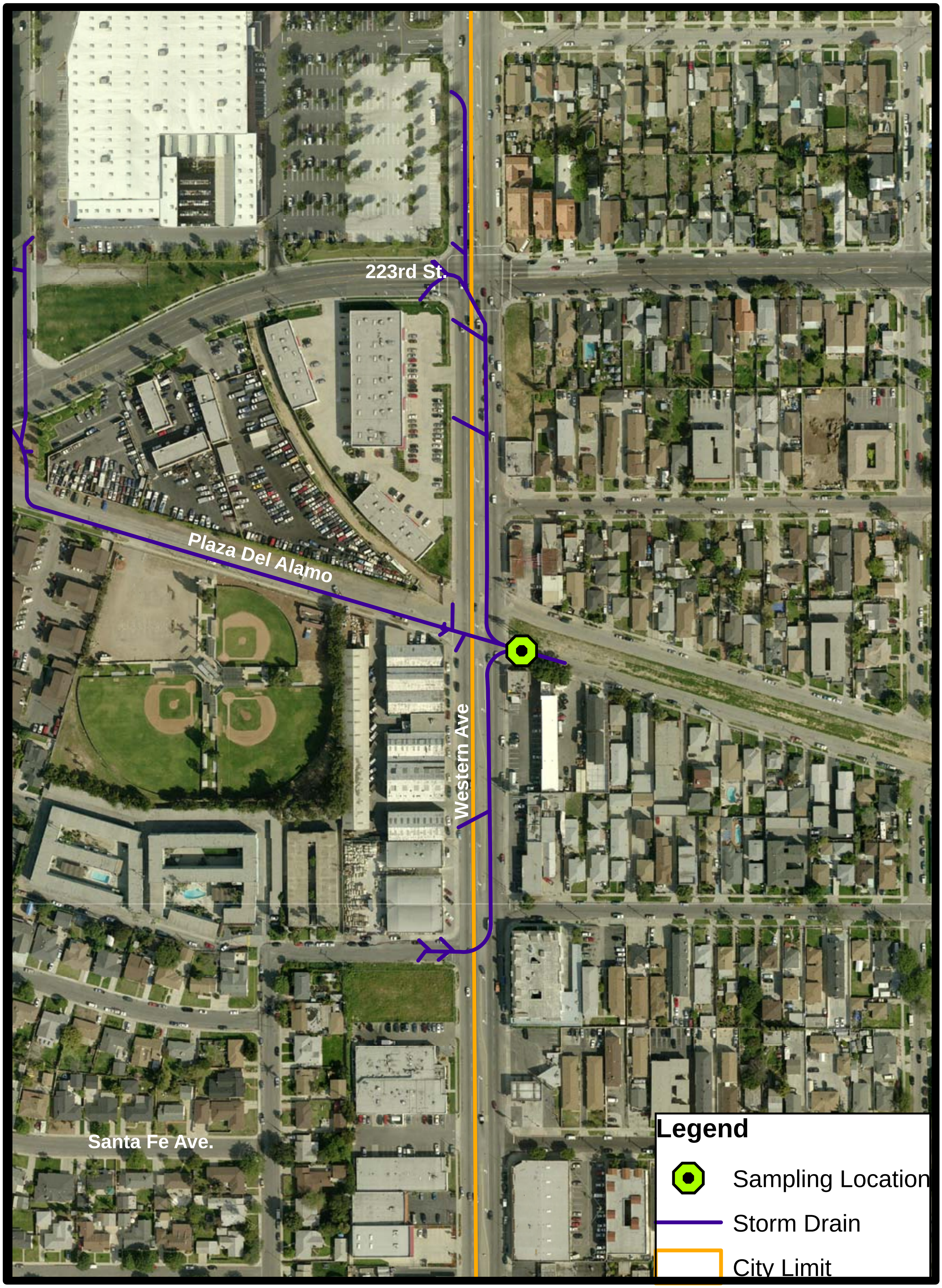
- Introduction and background information
- Documentation and summary of each sampling event, including photos
- Electronic copies of field conditions data sheets
- Summary discussion of results
- Tabular results of all samples, including quality assurance quality control samples, in electronic format, (Excel)
- Evaluation data quality based on QAPP requirements.

APPENDIX A

Detailed Maps of Sampling Locations

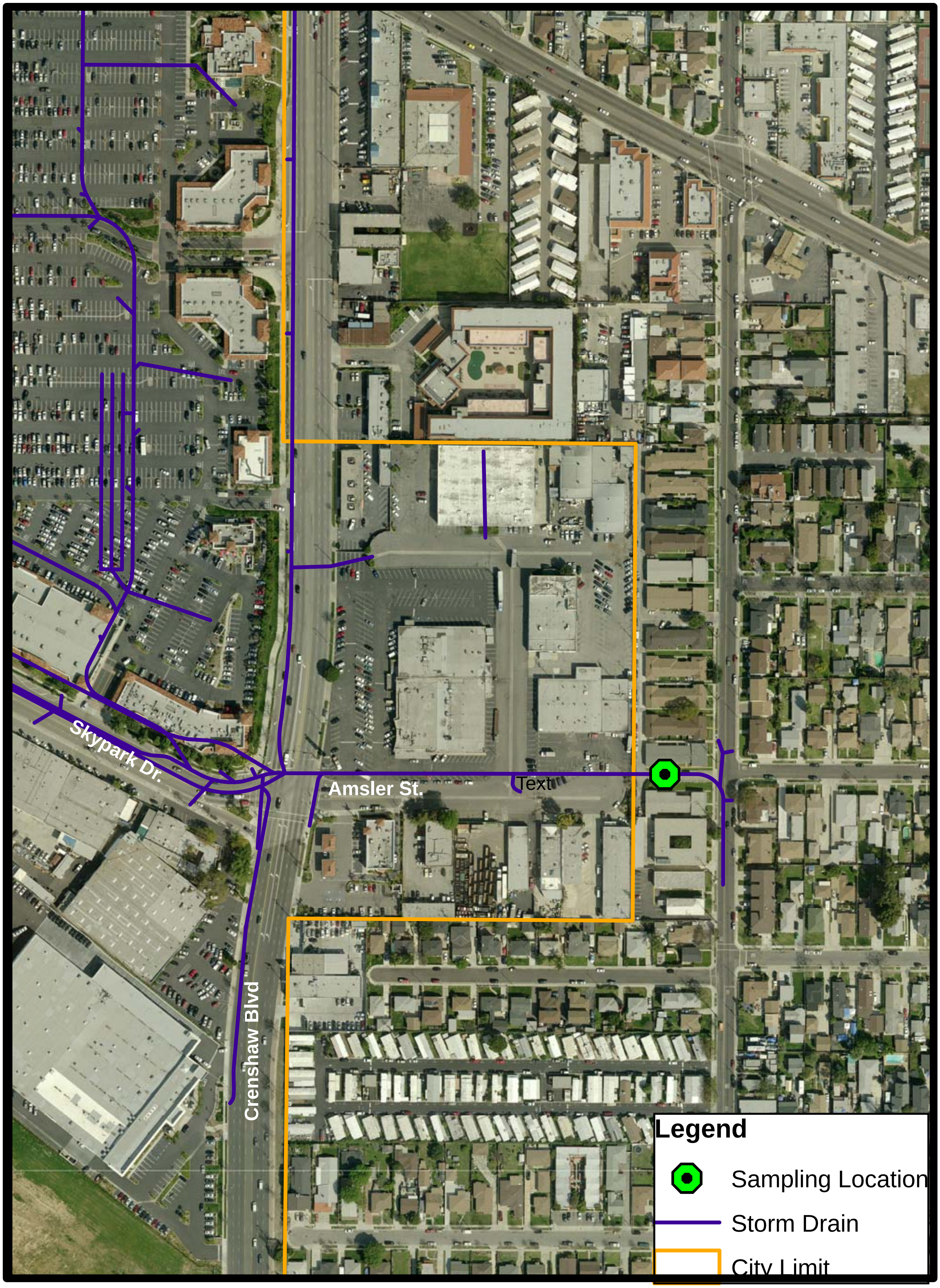
Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S1

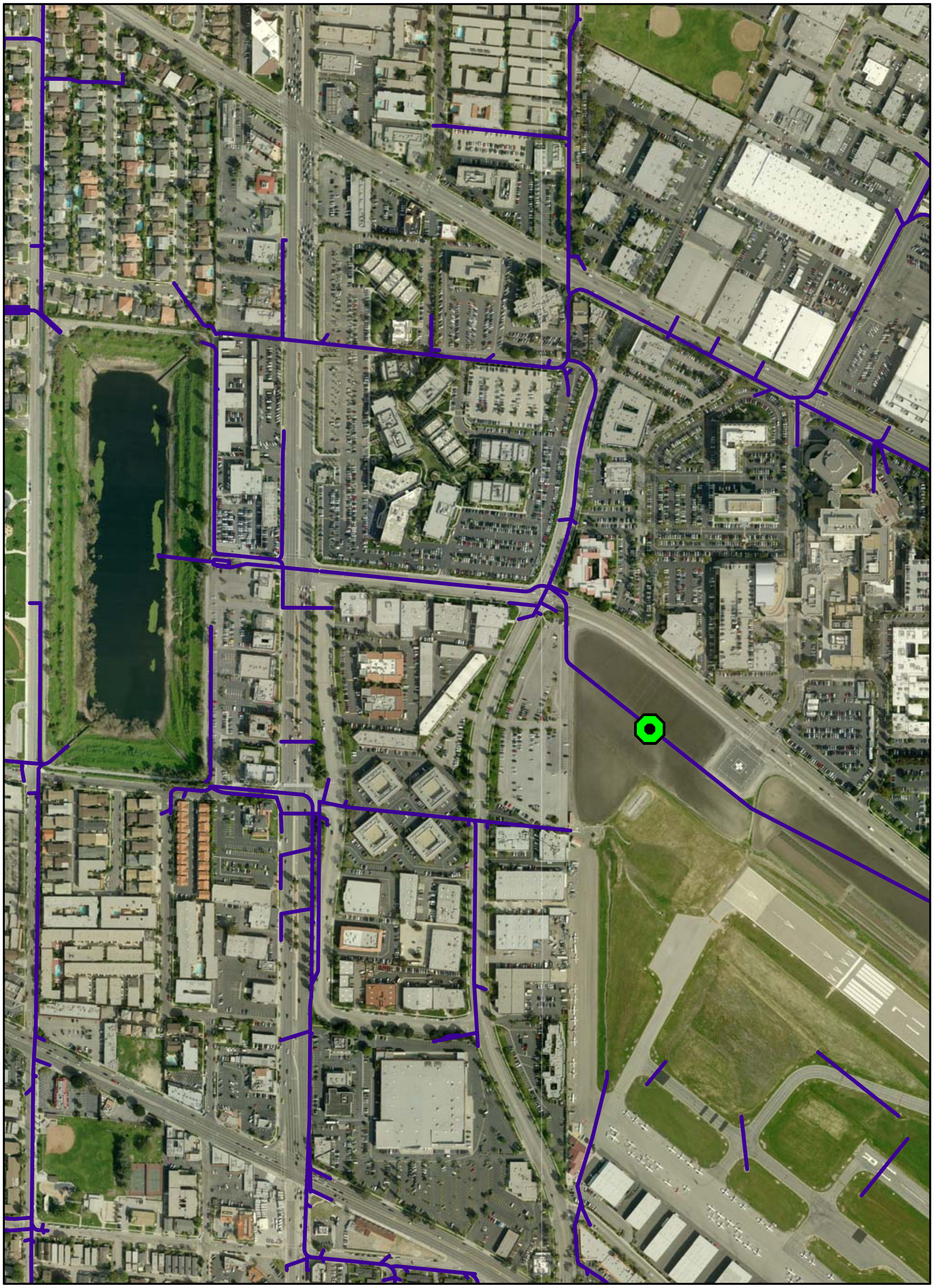


Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S2

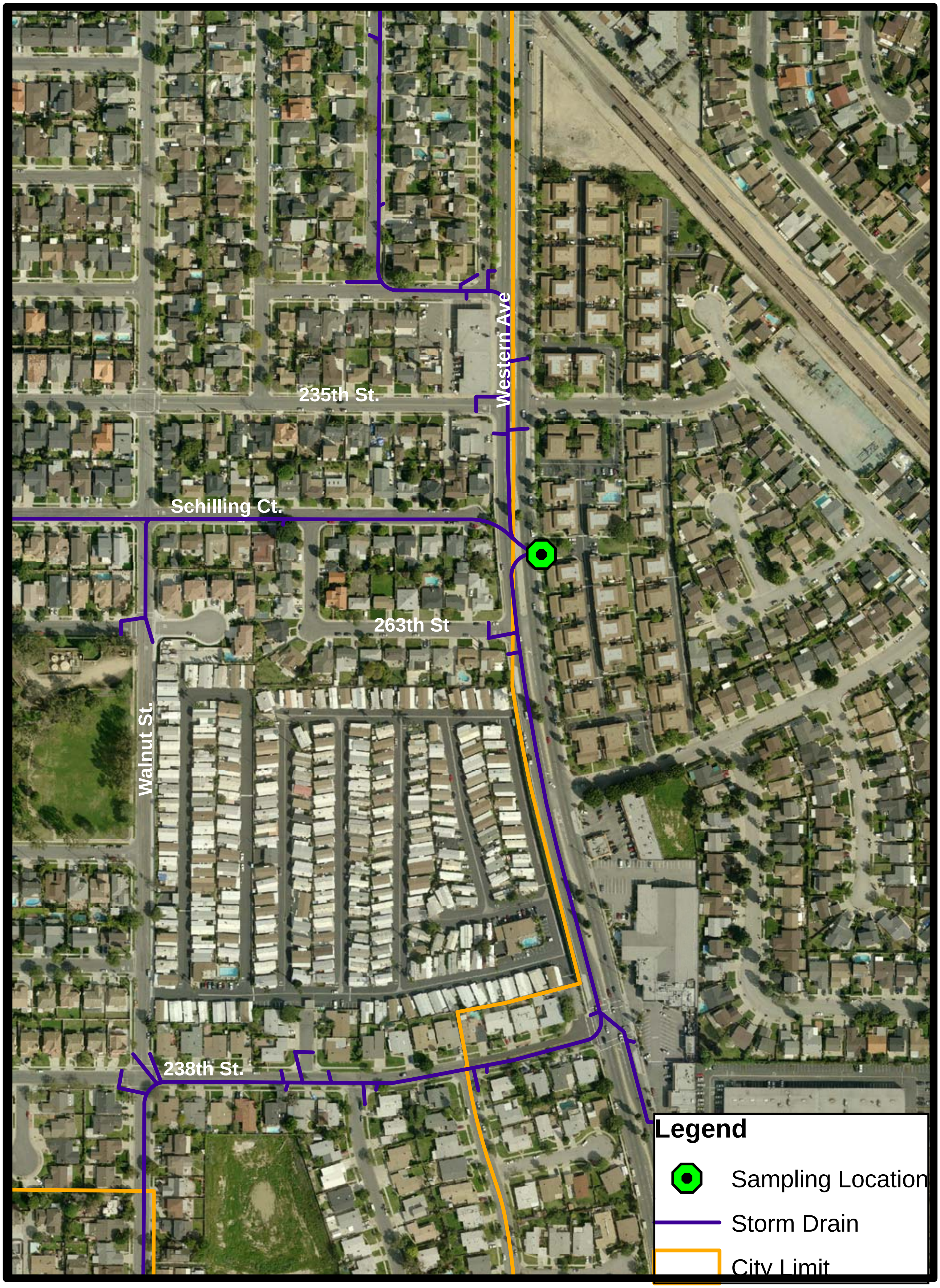


Stormwater Sampling Location: Tor-S3



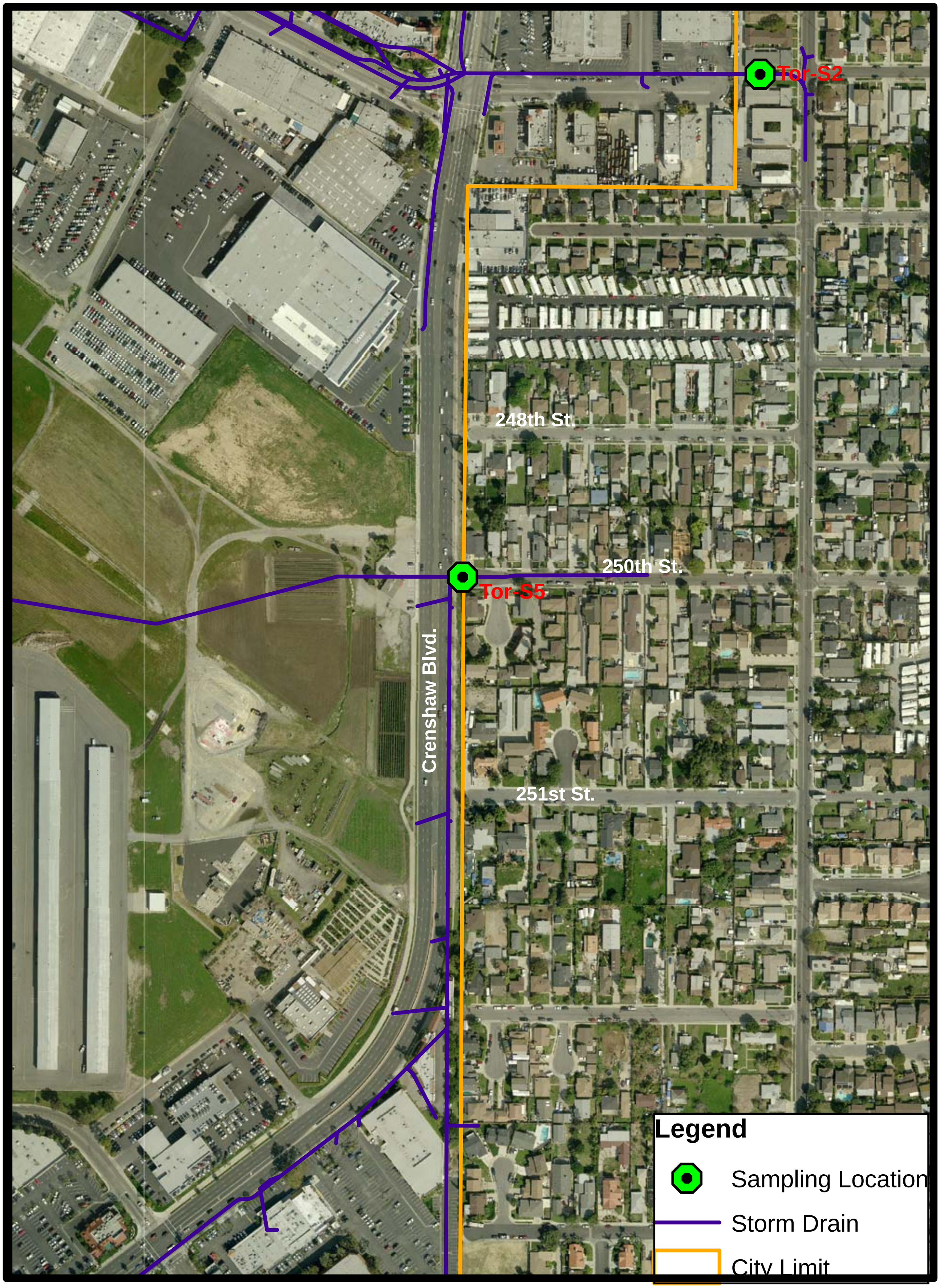
Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S4



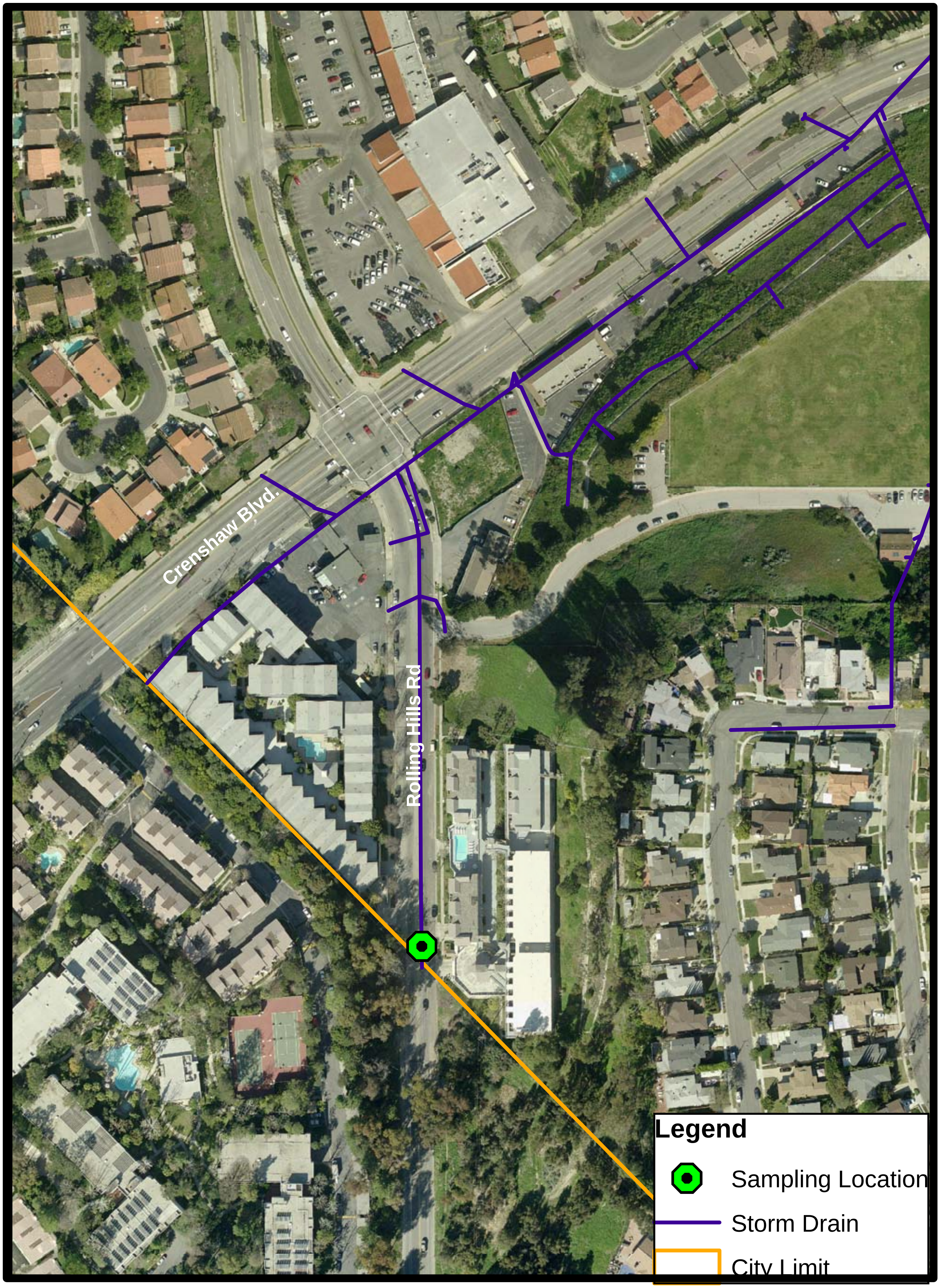
Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S5



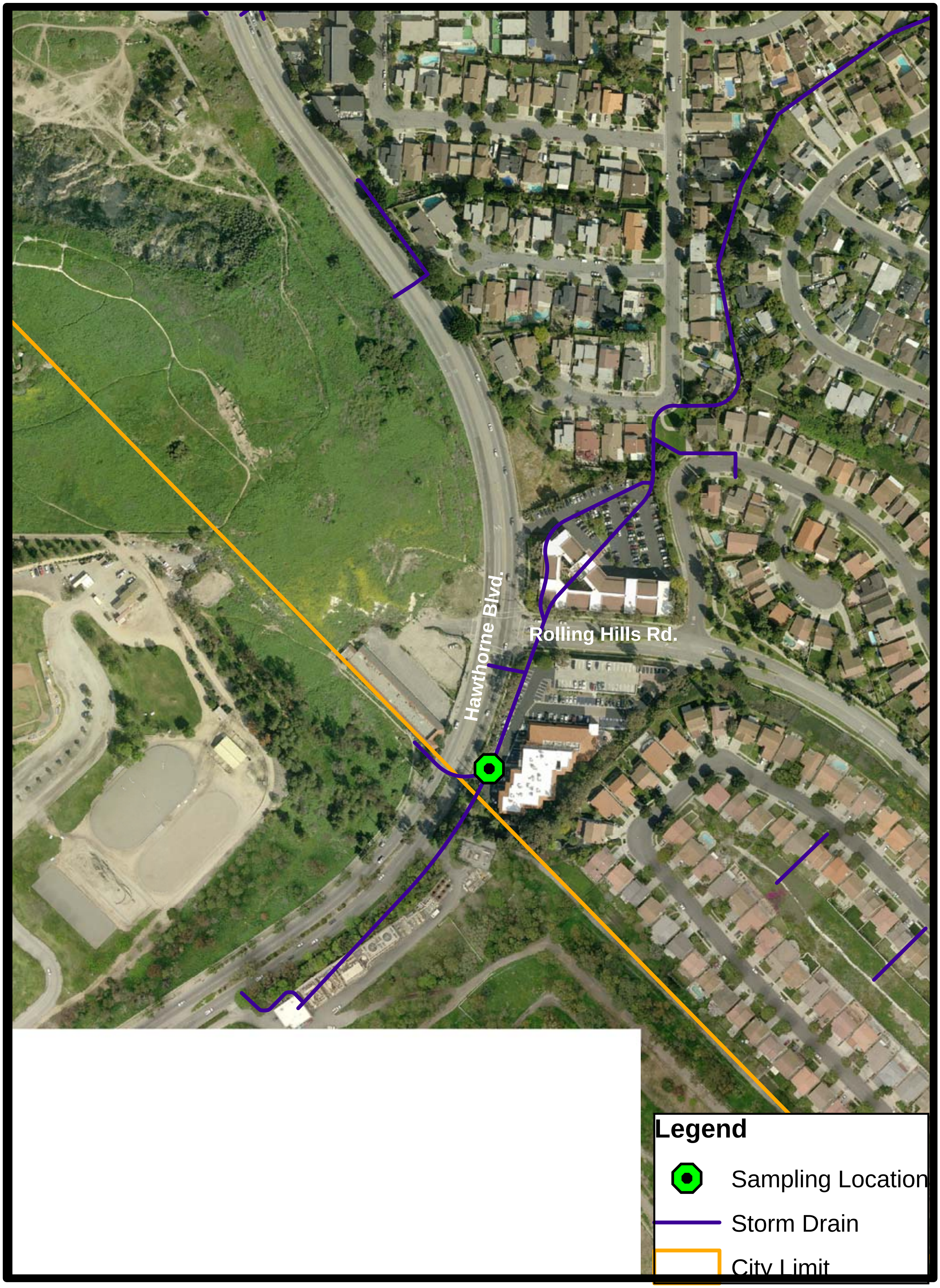
Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S6

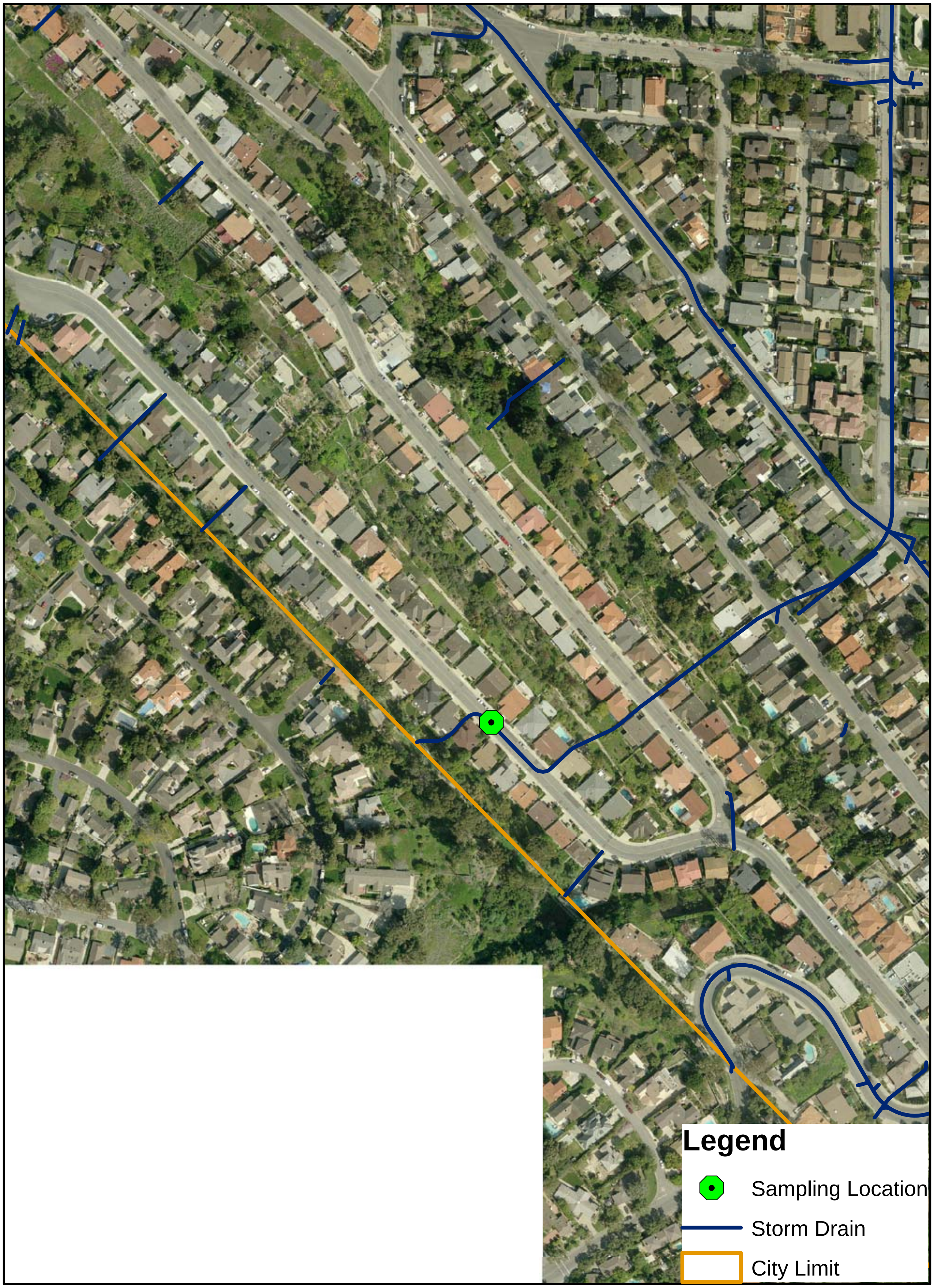


Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S7



Stormwater Sampling Location - Tor-S8



Preliminary Draft Beach Cities EWMP

Stormwater Sampling Location - Tor-S9

APPENDIX B

Field Data Sheet

Sampling Field Data

City of Torrance, California

Page______ of_______

Area Letter & Name or Run #: ________________________

Run: Scheduled / Makeup / Reopen / Extra

Collected by:____ **Initiated by:**________________________________

Date Collected:______________________________________ **Date/time Initiated:**____________________________

Missed Station	Area Letter	Station #	Military Time	Boat /Land/ Clams/Mussels	Temp °C	Random / Adverse/ Extra	Condition or Adversity	Open or Closed	Wind	Salinity ‰	A-1 MPN/100 ml MF CFU/100ml EC MPN/100 ml	Comments

Remarks:

CHAIN OF CUSTODY:

Relinquished by:	Date, Time & Temp°C	# Samples	Relinquished to:	Received by:	Date, Time & Temp°C	# Samples
Circle Water Quality Lab: Boothbay or Lamoine			**WQ Lab Staff Acceptance:**			

Entered by: _______ **Date:**_______

APPENDIX C

Chain of Custody

GENERAL CHAIN-OF-CUSTODY FORM

EVIDENCE/PROPERTY CUSTODY		Tracking Number
		Investigation ID Number
NAME OF RECIPIENT FACILITY	LOCATION	
NAME, TITLE AND CONTACT NUMBER OF PERSON FROM WHOM RECEIVED	ADDRESS	
LOCATION FROM WHERE OBTAINED	REASON OBTAINED	DATE/TIME OBTAINED

ITEM NO	QUANTITY	DESCRIPTION OF ARTICLES (Include model, serial number, condition and unusual marks or scratches)

		CHAIN OF CUSTODY		
ITEM NO.	DATE	RELEASES BY	RECEIVED BY	PURPOSE OF CHANGE OF CUSTODY
		SIGNATURE	SIGNATURE	
		PRINTED NAME & CONTACT INFORMATION	PRINTED NAME & CONTACT INFORMATION	
		SIGNATURE	SIGNATURE	
		PRINTED NAME & CONTACT INFORMATION	PRINTED NAME & CONTACT INFORMATION	
		SIGNATURE	SIGNATURE	

Chain-of-Custody (continued)

ITEM NO.	DATE	RELEASES BY	RECEIVED BY	PURPOSE OF CHANGE OF CUSTODY
		SIGNATURE	SIGNATURE	
		PRINTED NAME & CONTACT INFORMATION	PRINTED NAME & CONTACT INFORMATION	
		SIGNATURE	SIGNATURE	
		PRINTED NAME & CONTACT INFORMATION	PRINTED NAME & CONTACT INFORMATION	
		SIGNATURE	SIGNATURE	
		PRINTED NAME & CONTACT INFORMATION	PRINTED NAME & CONTACT INFORMATION	
		SIGNATURE	SIGNATURE	
		PRINTED NAME & CONTACT INFORMATION	PRINTED NAME & CONTACT INFORMATION	
		SIGNATURE	SIGNATURE	

FINAL DISPOSAL ACTION		
RELEASE TO OWNER OR OTHER (NAME/ORGANIZATION)		
DESTROY		
OTHER (Specify)		
FINAL DISPOSAL AUTHORITY		
ON THIS DOCUMENT PERTAINING TO THE INQUIRY/INVESTIGATION INVOLVING;		
ITEM(S) (IS)(ARE) NO LONGER REQUIRED AS EVIDENCE AND MAY BE DOSPOSED AS INDICATED ABOVE. *If articles must be retained do not sign, but explain in separate correspondence.*		
(Typed or Printed Name & Organization)	(Signature)	(Date)
WITNESS TO DESTRUCTION EVIDENCE		
THE ARTICLES LISTED AT ITEM NUMBERS (WAS)(WERE) DESTROYED BY THE EVIDENCE CUSTODIAN IN MY PRESENCE, ON THE DATE INDICATED ABOVE		
(Typed or Printed Name & Organization)	(Signature)	(pole)

Appendix D

Machado Lake Implementation Plan

City of Torrance, California
Redondo Beach, California

MACHADO LAKE NUTRIENT AND TOXICS TOTAL MAXIMUM DAILY LOAD

BMP IMPLEMENTATION PLAN

October 2014

199 S. Los Robles Avenue • Suite 530 • Pasadena, California 91101 • Phone: 626.535.0180
pw://Carollo/Documents/Client/CA/Torrance/9193A00/Deliverables/Draft Report/BMP-Implementation Plan

CITY OF TORRANCE, CALIFORNIA

MACHADO LAKE – NUTRIENT AND TOXICS TOTAL MAXIMUM DAILY LOAD

CITY OF TORRANCE, CALIFORNIA
BMP IMPLEMENTATION PLAN

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LIST OF ABBREVIATIONS

BMP	Best Management Practice
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGP	Construction General Permit
City	City of Torrance
County	Los Angeles County
CWA	Clean Water Act
DEM	Digital Elevation Model
EMC	Event Mean Concentration
ET	Evapotranspiration
GPS	Global Positioning System
HDSF	high-density single family
HSG	Hydrologic Soil Group
ISA	Impervious Surface Area
kg/yr	kilogram per year
KMHRP	Ken Malloy Harbor Regional Park
LA	Los Angeles
LACFCD	LA County Flood Control District
LID	Low Impact Development
MFR	multi-family residential
LARWQCB	Los Angeles Regional Water Quality Control Board
mg/L	milligram per liter
MRP	Monitoring and Reporting Plan
MS4	Municipal Separate Storm Sewer Systems
MWDSC	Metropolitan Water District Southern California
NPDES	National Pollutant Discharge Elimination System
OC	organochlorine
O&M	Operation and Maintenance
PCBs	polychlorinated biphenyls
PIPP	Public Information and Participation Program
PLAT	Pollutant Load and Analysis Tool
PRD	Permit Registration Documents
RARE	A Basin Plan designation for the aquatic life support category
REC 1	A Basin Plan designation for water contact recreational
REC 2	A Basin Plan designation for water non-contact recreational
SCAQMD	South Coast Air Quality Management District
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WLA	Waste Load Allocation
WMMS	Watershed Management Model System
WTM	Watershed Treatment Model

1.0 INTRODUCTION

This report documents the results of an effort to address impairments in the Machado Lake watershed with a comprehensive, phased approach of best management practice (BMP) implementation for the City of Torrance (City). To develop this plan, BMPs to treat stormwater and dry weather flows to reduce nutrients, sediment, and other pollutants such as metals, bacteria, and toxics were identified and selected. As part of that process, benefits of management activities were estimated, in terms of pollutant load reductions or improvement in water quality, to meet waste load allocations (WLAs) defined by approved total maximum daily loads (TMDLs) established for waters within the Machado Lake watershed. Table 1.1 provides a summary of the various existing and pending TMDLs associated with each body of water the City discharges into.

Table 1.1 Summary of TMDLs for City of Torrance

Body of Water	TMDL Name	Pollutant[(1)]	Resolution Number	Effective Date
Machado Lake	Nutrient	Nitrogen, Phosphorus	R08-006	11 March 2009
	Trash	Trash	2007-006	6 March 2008
	Toxics	Pesticides, PCBs	R10-008	2 September 2010
Dominguez Channel[(1)]	Toxics[(2)]	Copper, Lead, Zinc, DDT, PAHs, PCBs, Chlordane, Dieldrin, Cadmium, Chromium, Mercury	R11-008	Not Yet Effective (Approved by RWQCB on 5 May 2011)
Santa Monica Bay	Debris	Trash, Plastic Pellets	R10-010	Not Yet Effective (Approved by SWQCB 6 December 2011)
	Bacteria	Bacteria	2002-004 2002-022 2006-008	15 July 2003 15 July 2003 6 April 2006

Notes:
(1) Interim, final, and phased Waste Load Allocations (WLA) are listed in Chapter 3 where applicable.
(2) The Resolution Name for what is referred to here as the Dominguez Channel Toxics TMDL is "Los Angeles and Long Beach Harbors Toxic and Metals TMDLs." Dominguez Channel discharges into the Los Angeles and Long Beach Harbors.

The Machado Lake trash TMDL is being addressed this year with the Machado Lake TMDL Project. The process of BMP selection considered cost-effectiveness to promote a practical and implementable plan. This report also includes integrated approaches that consider BMPs that can address multiple pollutants cost-effectively, while considering parallel water resources planning strategies for the watershed.

The report is organized into nine sections that in summary provide the following information:

- Section 1 provides background information on the Machado Lake watershed and its impairments and associated TMDLs.
- Section 2 provides more detailed descriptions of the TMDL implementation area, including the geologic setting, land uses, hydrology, and hydraulics.
- Section 3 characterizes, evaluates, and prioritizes pollutants and their sources within the City's TMDL implementation area.
- Section 4 details an evaluation of existing programs, mainly nonstructural in nature, to address the pollutants of concern.
- Section 5 presents candidate sites for structural BMP implementation and describes the regulatory and permit requirements that might apply to the proposed BMPs and that might affect the timing, feasibility, and cost of management alternatives.
- Section 6 presents a alternatives evaluation of different structural and nonstructural BMP management options.
- Section 7 includes a discussion of the integrated nature of the plan and its relation to other water resources efforts in the region.
- Section 8 documents schedules for implementing BMPs to meet phased WLA schedule.
- Section 9 presents cost estimates for the BMP alternatives.

1.1 Machado Lake Watershed

1.1.1 Geographic Setting

Machado Lake has a total drainage area of approximately 23 square miles and is located within the Dominguez Channel Watershed Management Area, although it is not tributary to the Dominguez Channel. Machado Lake overflows into Wilmington Drain during peak storm events. The lake itself is under the jurisdiction of the City of Los Angeles, while the drainage area is within the jurisdiction of several cities and unincorporated portions of Los Angeles County (County). The lake is located in the Ken Malloy Harbor Regional Park (KMHRP), which is a 231-acre Los Angeles City Park serving the Wilmington and Harbor City areas.

The lake was originally created for inclusion into Harbor Regional Park in 1971, and intended for boating and fishing.

A map of the Machado Lake watershed and the different jurisdictions located within the drainage area is shown on Figure 1.1. The figure includes the boundary of the Machado Lake watershed and major storm drains.

1.1.2 Machado Lake Responsible Agencies

The responsible parties located within the Machado Lake Watershed include the cities of Los Angeles, Torrance, Carson, Lomita, Rolling Hills, Rolling Hills Estates, Rancho Palos Verdes, Redondo Beach, and Palos Verdes Estates, and unincorporated Los Angeles County.

1.1.3 TMDL Implementation Area

The area of Torrance located in the watershed accounts for 30 percent of the total drainage area. The portion of City Redondo Beach is about 0.2 percent of the entire watershed and flows to a City of Torrance catch basin; therefore, this plan also addresses Machado Lake TMDL compliance for the City of Redondo Beach. For the purposes of this report, this area of Torrance and Redondo Beach located within the watershed is called the TMDL Implementation Area.

The Madrona Marsh and Sump watershed discharges stormwater into Walteria Lake watershed. Madrona Marsh Restoration and Enhancement Project installed passive wetland treatment system to treat water in the sump for nutrients. Madrona Sump Dredging Project will remove nutrient and toxic rich sediments, therefore not part of this plan.

1.2 Water Quality Impairments

1.2.1 Designated Beneficial Uses

The existing beneficial uses of Machado Lake, as defined by the Los Angeles Regional Water Quality Control Board (LARWQCB) in the Basin Plan, include recreation (REC 1 and REC 2) and aquatic life support (WARM, WILD, RARE, and WET). The Basin Plan applies the municipal supply (MUN) beneficial use designation to Machado Lake, qualified by an asterisk, as a potential future use. Conditional designations are not recognized under federal law and are not water quality standards requiring TMDL development at this time.

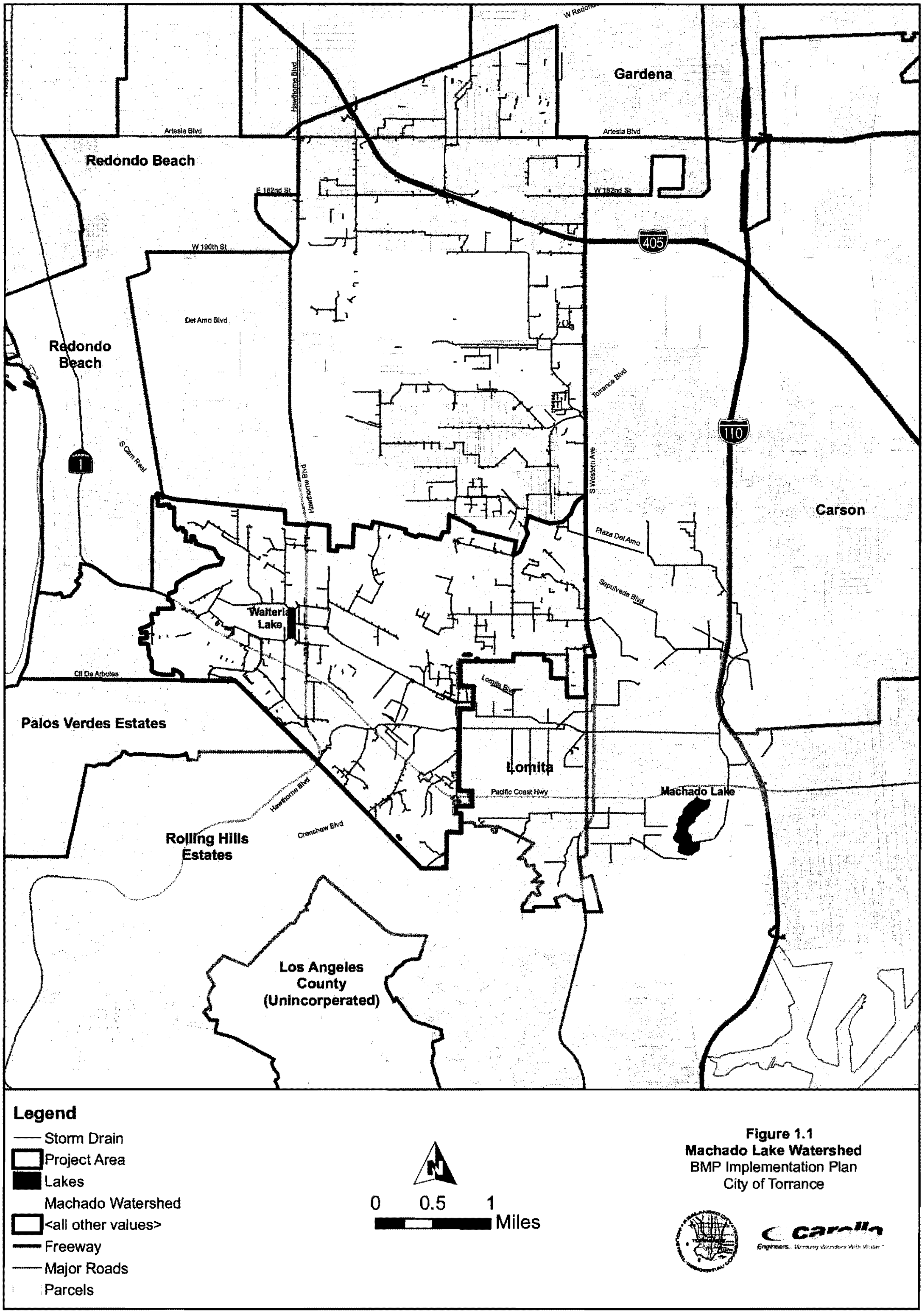


Figure 1.1
Machado Lake Watershed
BMP Implementation Plan
City of Torrance

1.2.2 2010 Section 303(d) List

Section 303(d) of the Clean Water Act (CWA) requires that "Each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for 303(d) listed impaired waters and establish TMDLs for such waters. A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the water body to assimilate pollutant loadings (the Loading Capacity) is not exceeded. TMDLs are required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis.

Nutrient enrichment to Machado Lake has resulted in high algal productivity; algal blooms have been observed in the lake during summer months. High nutrient concentrations also contribute to excessive and nuisance macrophyte growth. Algae respiration and decay remove oxygen from the water column, leaving insufficient oxygen for fish and other organisms to breathe. The decay of algal blooms and other eutrophic related impairments can also create offensive odors. This nutrient enrichment, or eutrification of the ecosystem, causes impaired Warm Freshwater Habitat (WARM), Water Contact Recreation (REC 1), and Non-contact Water Recreation (REC 2) beneficial uses in Machado Lake. Because of the high nutrient concentrations, algal blooms, odors and eutrophic conditions, Machado Lake was placed on the Clean Water Act 303(d) list of impaired waterbodies in 1998, 2002, and 2006. A schedule for developing TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999.

The consent decree combined waterbody-pollutant combinations in the Los Angeles Region into ninety-two (92) TMDL analytical units. In accordance with the consent decree, the Nutrient TMDL addresses nitrogen and phosphorus compounds and related effects for Machado Lake (analytical unit #76).

Machado Lake is listed in the 1998, 2002, 2006, and 2008 Clean Water Act 303(d) lists of impaired water bodies as impaired due to chlordane, DDT, Dieldrin, Chem A, and PCBs in tissue. In addition to these approved 303(d) listings, there are sufficient data to document chlordane, DDT, and PCB impairments in sediment. The impairments were addressed in the Toxics TMDL. Chem A chemicals are bioaccumulative pesticides, which include chlordane and Dieldrin, and were addressed specifically through chlordane and Dieldrin. Clean Water Act 303(d) listing for Machado Lake and Wilmington Drain are presented in Table 1.2. TMDLs have been completed for nutrients, toxics, and trash.

Table 1.2 Water Impairments of Machado Lake and Wilmington Drain

Water Body	Impairment
Machado Lake	Ammonia Algae Eutrophication Odor ChemA Chlordane DDT Dieldrin PCBs Trash
Wilmington Drain	Coliform Bacteria Copper Lead

The Machado Lake Trash TMDL states that agencies can comply *with* the WLAs by installing full capture trash screens on catch basins that discharge to Machado Lake through a progressive eight-year implementation schedule. Full capture trash screen must be installed on 20% of a city's catch basins by March 6, 2012 with 20 percent more each year until 100% of catch basins have trash screens by March 6, 2016.

The City is complying with the TMDL requirements through a joint project with the Cities of Lomita, Carson, Rolling Hills Estates, Palos Verdes Estates, and Rancho Palos Verdes to install Automatic Retractable Screens and/or Connector Pipe Screens onto catch basins that are tributary to the Machado Lake. Work within the City of Torrance also includes the installation of No Parking signs for Street Sweeping within the portion of Torrance tributary to Machado Lake.

1.3 Objectives of the BMP Implementation Plan and Approach

This BMP Implementation Plan outlines the management actions that may be necessary to ultimately attain compliance with the Machado Lake Nutrient and Toxics TMDLs (LARWQCB, 2009), within the Torrance TMDL Implementation Area of the Machado Lake watershed. The BMP Implementation Plan calls for an integrated, adaptive management approach to utilize available resources effectively and efficiently. As new information becomes accessible through monitoring, the continued study of drainage patterns, diagnosis of problem sources, and new technologies for dry and wet weather treatment, the plan may be modified as necessary. Implementation of the management actions described by the plan depends on feasibility, available funding, site-specific conditions, and various other factors.

1.3.1 Focus of the Plan

The Machado Lake BMP Implementation Plan must include implementation methods, a schedule, and proposed milestones to achieve compliance of the TMDL WLAs. The Plan development requires identifying and selecting BMPs to treat stormwater or reduce pollutant loads, as well as developing estimates of benefits in terms of load reductions to meet WLAs. However, the BMP selection process must consider the cost-effectiveness to provide assurance that plans are practical and implementable.

The goal of the implementation plan is to address current TMDLs except trash, with consideration of future potential TMDLs. The nutrients TMDL is considered the primary focus of this implementation plan. A secondary focus is placed on toxics through removal of suspended sediments that toxics are associated with. The third focus is placed on trash because reporting on progress toward the trash TMDL implementation occurs annually and through a separate process. However, proposed BMPs that address trash have the potential to provide added benefit in addressing other pollutants, which is assessed in this implementation plan. Total nitrogen (TN) and total phosphorus (TP) source characterizations are provided in the plan.

This implementation plan includes integrated approaches that consider BMPs that can address multiple pollutants cost-effectively. Additional benefits of BMPs, such as water storage/recharge and reuse, providing recreation space, improved natural habitat, source control and public education, are considered in this implementation plan.

This implementation plan describes management options that are limited to area of the City of Torrance located within the Machado Lake watershed. This area is termed the *TMDL Implementation Area* in this report and is represented in red on Figure 1.1. Some of the proposed nonstructural or programmatic BMPs, such as staff training or education programs, could apply citywide. Rolling Hills Estates watershed is a tributary of Torrance TMDL Implementation Area, and flows directly to Walteria Lake, therefore not addressed in this plan.

1.3.2 TMDL Target

Key factors influencing the level of BMP implementation are the stormwater management targets expected to be achieved. For this project, multiple TMDLs and associated WLAs for stormwater runoff have been established for Machado Lake, which must be considered as a priority for developing the BMP implementation plan. The following provides a summary of applicable wet weather TMDL WLAs and implementation requirements, and methods for translating the requirements into management targets to address wet weather pollution.

1.3.2.1 Nutrients

The Machado Lake Nutrient TMDL was developed by the LARWQCB in 2009. The U.S. Environmental Protection Agency (USEPA) approved the Nutrient TMDL on March 11, 2009, and the approval letter was posted on April 8, 2009. The Nutrient TMDL was developed to address nutrient-related beneficial use impairments including the following Section 303(d) listings: eutrophication, algae, ammonia, and odor.

The City is subject to the requirements of the Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) TMDL per the LARWQCB's Resolution R08-006. Under the Regional Board's resolution, the City shall submit to the Regional Board's Executive Officer a Monitoring and Reporting Plan (MRP) within 1 year of the effective date of the resolution or propose a Special Study Work Plan following the requirements of one of three optional studies. The Special Study Work Plan details the approach proposed by the City to perform Optional Study No. 3, to assess compliance with the WLA on a mass basis for total nitrogen and total phosphorus originating from the City's TMDL Implementation Area. The Special Study Work Plan is complete and turned in to the Regional Board.

Resource agencies, local governments, project implementers, the scientific community, environmental groups, decision-makers at the city, county, state, and federal levels, and many others have continued to take meaningful steps towards the restoration of Machado Lake and its basin. Among these efforts, restoration activities are expanding through continued implementation of erosion control, stormwater management, and riparian restoration projects, development of the Machado Lake Nutrient TMDL that is providing a quantitative, science-based approach for pollutant reduction, and a strong research/monitoring effort to evaluate key ecological processes and response to water quality improvement projects. The Machado Lake Nutrient TMDL allows for the establishment of annual mass-based WLAs for Total Phosphorus (TP) and Total Nitrogen (TN) equivalent to monthly average concentrations of 0.1 milligram per liter (mg/L) TP and 1.0 mg/L TN, based on approved flow conditions. When the concentration based WLAs are met under the approved flow condition of 8.45 hm3, the annual mass of the TP discharged to the lake will be 845 kg and the annual mass of TN discharged to the lake will be 8,450 kg. The City of Torrance accounts for 35.6 percent of the Machado Lake Watershed. Table 1.3 lists the interim and final WLAs based on this area.

Table 1.3 City of Torrance Nutrient TMDL Mass-based Waste Load Allocations

Responsible Party	Years after TMDL Effective Date	TMDL Attainment Date[1]	Total Phosphorus (kg/yr)	Total Nitrogen (kg/yr)
City of Torrance	5	March 11, 2014	3,760	7,370
	9.5 (final WLAs)	September 11, 2018	301	3,008

Note:
(1) Effective date of the nutrient TMDL is March 11, 2009.

1.3.2.2 Toxics

Machado Lake is listed as impaired for chlordane, Chem-A, DDT, Dieldrin and PCBs. The LAWQCB adopted the Machado Lake Toxics Total TMDL on September 2, 2010 (LARWQCB, 2010) and was approved by the State Water Quality Control Board and the USEPA. The pollutants listed within the Toxics TMDL include organochlorine (OC) pesticides and polychlorinated biphenyls (PCBs). These pollutants are associated with suspended sediments; therefore, the WLAs were calculated based on the fraction of suspended solids loading produced by each stormwater discharger, and assigned for both dry and wet weather. Compliance is measured either at the storm drain outfall of the permittee's drainage area, at representative storm drain outfalls representing the combined discharge of cooperating parties (if a coordinated compliance option is chosen by multiple permittees), or at an alternative compliance point approved by the Regional Board Executive Officer.

The WLAs assigned to Municipal Separate Storm Sewer Systems (MS4) permittees in the Toxicity TMDL BPA are concentration-based allocations (equal to the sediment numeric targets), and are listed in Table 1.4. The Toxics TMDL requires compliance with these WLAs by September 30, 2019.

Table 1.4 MS4 Permittees Toxics TMDL Waste Load Allocations

	Numeric Target for Sediment	Waste Load Allocation for Suspended Sediment-Associated Contaminants[1]	
Parameter of Concern	**Concentration (µg/kg dry weight)**	**Concentration (µg/kg dry weight) Period**	**Compliance Averaging Period**
Total PCBs	59.8	59.8	3-year average
DDT (all congeners)	4.16	4.16	3-year average
DDE (all congeners)	3.16	3.16	3-year average
DDD (all congeners)	4.88	4.88	3-year average
Total DDT	5.28	5.28	3-year average
Chlordane	3.24	3.24	3-year average
Dieldrin	1.9	1.9	3-year average

Note:
(1) The WLA applies to all MS4 Permittees including the County, Caltrans, General Construction and, industrial Stormwater Permittees, and other non-stormwater NPDES Permittees.

Suspended solids serve as carriers of toxics such as pesticides, dioxins and PCBs. Removal of suspended solids therefore, will also lead to toxics removal. This Plan addresses toxics through the removal of sediments. Removal of toxics is calculated as a fraction of suspended sediments removed by proposed stormwater treatment devices. This Plan relied on toxics data developed from the Domingues Channel Flow Monitoring Program.

Estimated baseline load for toxics is presented in Section 3 of this Plan.

1.3.2.3 Trash

The Machado Lake Trash TMDL became effective in March 2008. The trash monitoring and reporting plan (TMRP) was submitted to the LARWQCB in September 2008, and conditionally approved in December 2008. This BM P Implementation Plan does not specifically address the Trash TMDL because projects to address trash have already been completed or funded.

1.3.3 <u>Scheduled Total Maximum Daily Load</u>

Wilmington Drain, to which all of the County areas drain shown on Figure 1.1, is listed in the 303(d) list as impaired for metals (copper and lead) and bacteria. The additional pollutants of concern listed in Machado Lake are scheduled for TMDL development in 2014 or 2019. This Implementation Plan does not directly address metals or bacteria impairments in Wilmington Drain.

2.0 MACHADO LAKE WATERSHED

The Machado Lake watershed is situated within the Dominguez Channel Watershed Management Area. Machado Lake is separate from Dominguez Channel and discharges, under storm conditions, to the Los Angeles Harbor.

2.1 City of Torrance TMDL Implementation Area

The City is located about 15 miles south of Downtown Los Angeles (LA), in southern LA County, just north of the Palos Verdes Hills. The City was incorporated on May 12, 1921, and is just over 20.5 square miles in area. The City is bounded by Redondo Beach on the west and north, Lawndale and Gardena on the north, LA on the east, Lomita to the southeast, and Rolling Hills Estates and Palos Verdes Estates on the south. The City is also bounded by approximately 4,000 feet of Santa Monica Bay coastline. The City's storm conveyance systems are interconnected with neighboring city systems. Neighboring cities located at generally higher elevation such as Rolling Hills Estate and Palos Verde Estate discharge stormwater into the City's and/or LA County's storm conveyance systems located within the City's boundaries. Figure 2.1 shows an aerial view of the watershed and Figure 2.2 gives an overview of land uses in TMDL Implementation Area.

The TMDL Implementation Area is about 4,239 acres (6.6 square miles), which equals approximately 32 percent of the City of Torrance. The TMDL Implementation Area also includes a very small area of Redondo Beach that drains directly to a Torrance catch basin. The land use category with the largest faction within the TMDL implementation area is residential (43 percent), while open space accounts for about 18 percent. Residential land uses include high-density single family (HDSF), multi-family residential (MFR), and mobile homes. The land uses in the Implementation Area are listed in Table 2.1.

Table 2.1 Land Use in TMDL Implementation Area

Land Use	Acreage	% TMDL Implementation Area
Residential	1,810	43
Commercial	419	10
Industrial	256	6
Transportation	996	23
Open Space	758	18
Total	**4,239**	**100**

Figure 2.1
Overview of TMDL Implementation Area
BMP Implementation Plan
City of Torrance

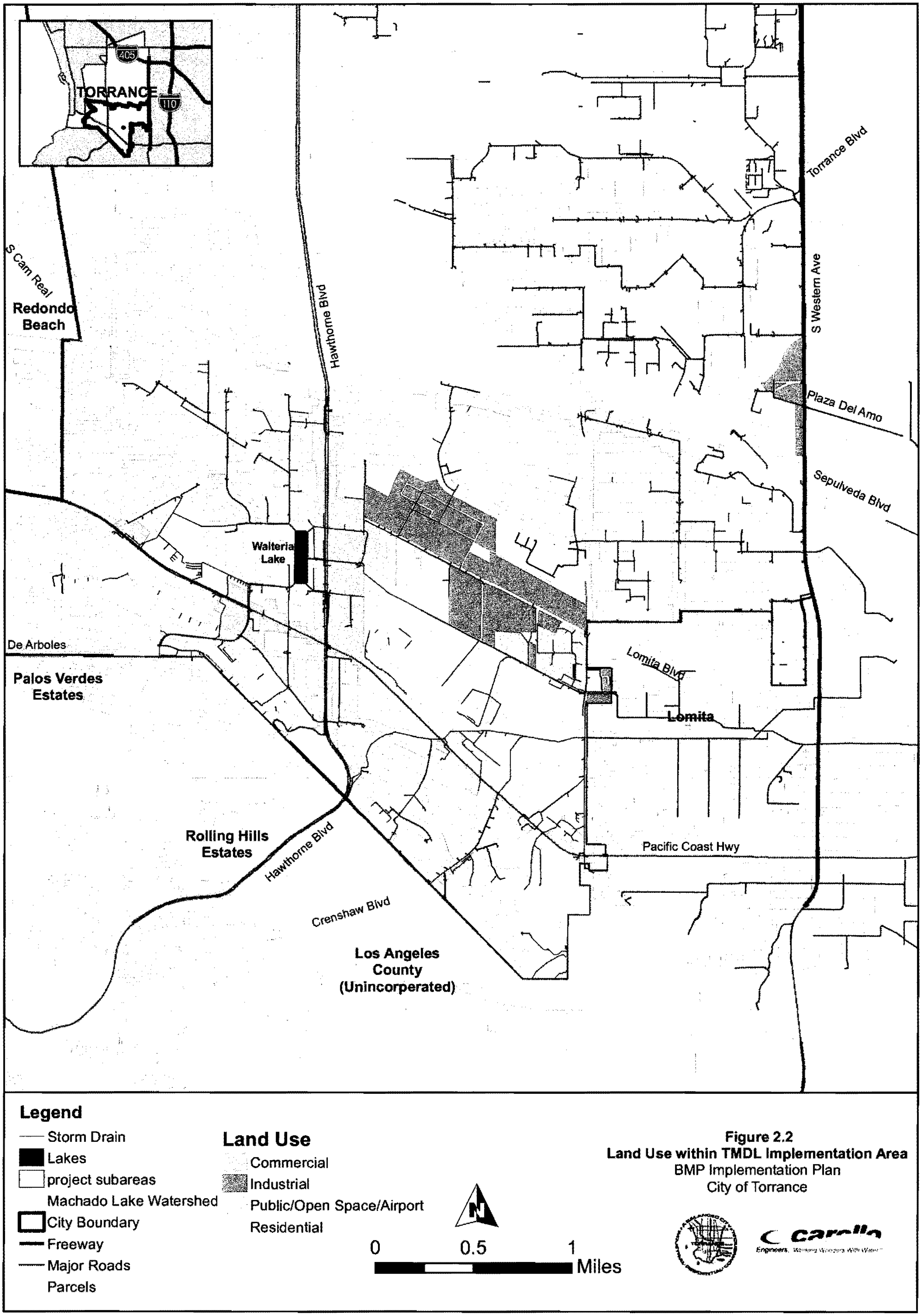


Figure 2.2
Land Use within TMDL Implementation Area
BMP Implementation Plan
City of Torrance

2.2 Geologic Setting and Soil

The soils found within the Machado Lake watershed are predominantly loam and clay. The most common soil type is Ramona Loam, which is observed in the TMDL Implementation Area. Ramona Loam is a compact soil with a large runoff coefficient at high rates of precipitation. Areas such as the Rolling Hills Estates and the lands along Highway 1 are composed of several different classifications of clay and loam. Diablo Clay Loam and Montezuma Clay.

The predominant soil types found in the TMDL Implementation Area are listed by their percentage in Table 2.2. The soil types found across the TMDL Implementation Area are displayed in Figure 2.3.

Table 2.2 Soil Types Distribution

Soil Classification[1]	Percentage of Soil within TMDL Implementation Area
Ramona Loam	21.4%
Yolo Sandy Loam	8.0%
Dublin Clay Adobe	35.3%
Oakley Fine Sand	35.4%
Total	**100.0%**

Note:
(1) LACDPW 2006 Hydrology Manual

2.3 Watershed Hydrology

As shown on Figure 1.1, the Machado Lake watershed is located in the southwestern area of the Dominguez Channel watershed and includes portions of the Cities of Los Angeles, Torrance, Lomita, Rolling Hills, Rolling Hills Estates, Carson, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, and the communities of unincorporated Los Angeles County, including Wilmington and Harbor City. As shown, a large portion of the Machado Lake watershed consists of the hilly regions of Rolling Hills Estates and Rolling Hills. This portion of the watershed is unique, as it consists of relatively steep hills with drainage into the canyons.

Machado Lake is about 40 acres in area, while the Machado Lake wetlands cover an anear of approximately 64 acres. The lake and wetlands are located within the Ken Malloy Harbor Regional Park in the southeastern corner of the Machado Lake Watershed. Both Machado Lake and the Machado Lake wetlands serve as flood retention basins for the Machado Lake Watershed.

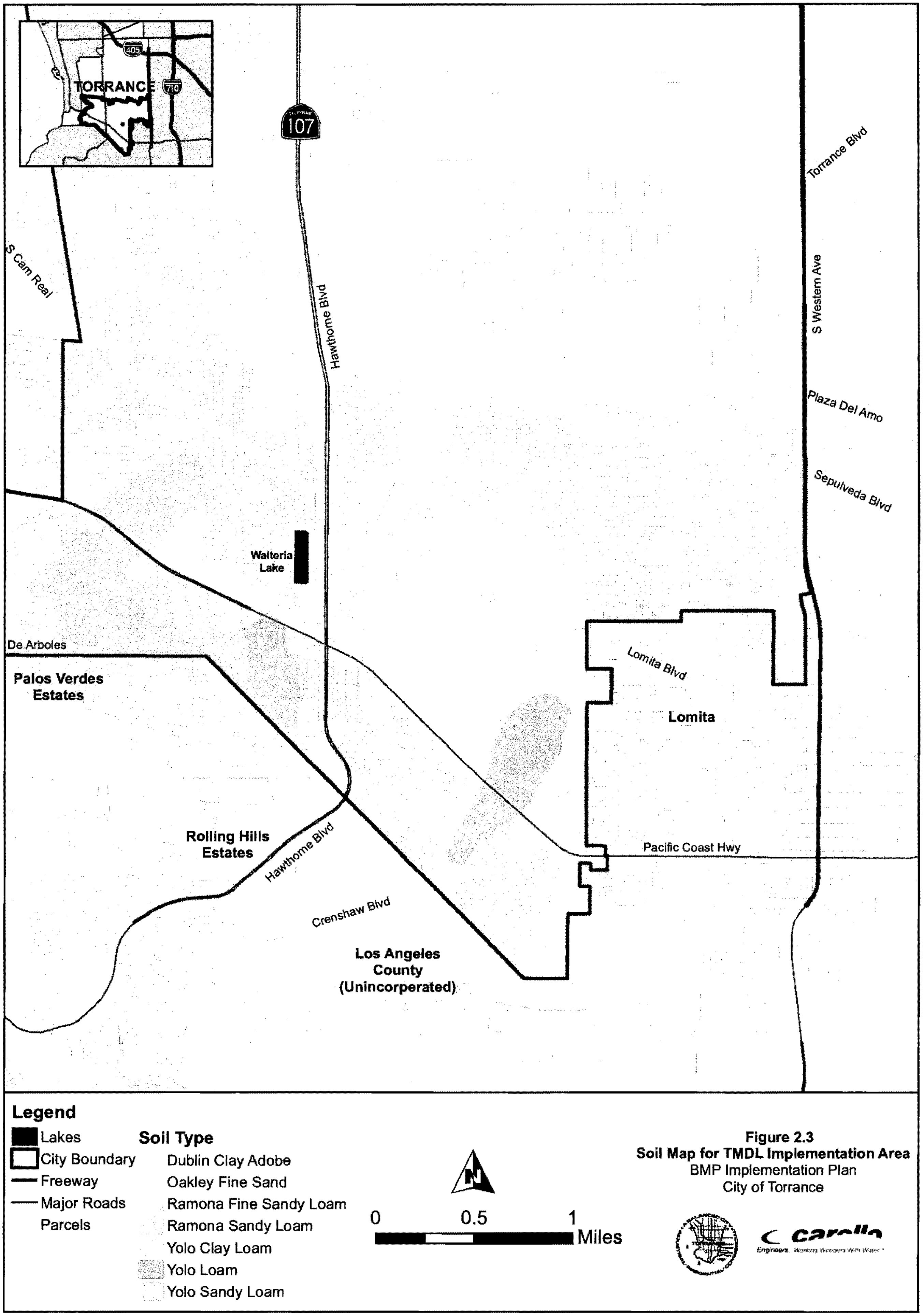


Figure 2.3
Soil Map for TMDL Implementation Area
BMP Implementation Plan
City of Torrance

The Machado Lake watershed can be divided into six primary subdrainage areas. These subdrainages are:

- The Walteria Lake
- Project 77/510
- Wilmington Drain
- Project 643 (72-inch Storm Drain)
- Project 643 (Figueroa Drain)
- Private Drain 553.

2.4 Watershed Hydraulics

As the TMLD implementation area is highly urbanized, stormwater drainage is primarily conducted through an extensive network of underground storm drain facilities. The Los Angeles County Department of Public Works maintains the system of storm drains in the City of Rolling Hills Estates. The primary use of the Dominguez Channel and all other open channels in the Dominguez Channel watershed (including Wilmington Drain, Machado Lake, and Madrona Marsh) is flood protection.

Machado Lake receives urban and storm water runoff from a complex network of storm drain systems. The first of three primary storm drain channels that flow into Machado Lake is the Wilmington Drain. Approximately 65 percent of the runoff from the Machado Lake Watershed flows through the Wilmington Drain into Machado Lake. The other two primary storm drain channels are the Project No. 77 Drain and the Harbor City Relief Drain. Several smaller storm drains also discharges into Machado Lake, including Project No. 643's Figueroa Street Outlet and a 72-inch diameter storm drain outlet. Machado Lake discharges at the southern end by overflowing a concrete dam into the Machado Lake wetland. Water discharges from the wetland through the Harbor Outflow structure and into the West Basin of the Los Angeles Harbor.

The Walteria Lake, located within the City's boundaries, is owned and operated by LA County Flood Control District. It is approximately 1,005 acre-feet in capacity and receives raw stormwater mainly from Rolling Hills Estates, Palos Verdes Estates, and the City of Torrance. Effluent from the lake is pumped at a maximum rate of 57 cubic feet per second (cfs) through a force main system into a 54-inch diameter drain line that lies under Skypark Drive. The discharge eventually leaves the City near the intersection of Crenshaw Boulevard and Amsler Street.

3.0 POLLUTANT SOURCE CHARACTERIZATION AND PRIORITIZATION

This section identifies the potential sources of the pollutants of concern derived from both point and nonpoint sources. The discussion is provided in several parts: modeling results, specific pollutant sources, and a source prioritization. Watershed monitoring results are summarized for reference in Appendix B. The focus of this characterization and prioritization is primarily within the City TMDL Implementation Area. Both wet and dry conditions are discussed. The City's Pollutant Load and Analysis Tool (PLAT) was used to quantify the average annual pollutant loading of nutrients and other pollutants from the TMDL Implementation Area.

3.1 Special Study

To meet the Nutrient TMDL's Optional Study #3 requirements and the aforementioned objectives, the Work Plan outlined an approach that utilized previously existing information to develop mass-based WLAs, and used a combination of water quality sampling and hydrologic modeling to characterize current wet and dry weather loading from the TMDL Implementation Area. Water quality samples were collected monthly at each monitoring location. During the wet season, dry weather sampling events were scheduled seven days after measurable precipitation, or after flow rates had returned to base levels typical of the season, whichever period was shorter.

A total of eight monitoring sites were selected for the Special Study. The characteristics of the monitoring sites are presented in Tables 3.1 and 3.2. Figure 3.1 shows the monitoring sites and associated drainage areas. Drainage areas were determined using GIS layers, provided by the City, of storm drains and the flow paths of Wilmington Drain. Land use calculations were determined using a GIS layer obtained from the City.

Monitoring for nitrogen and phosphorus constituents was performed during the Special Study. The monitoring results for total nitrogen, total phosphorus, and flow rate are displayed on Figure 3.2 and summarized in Table 3.3. The amount of pollutants entering the City from neighboring cities are represented by monitoring locations Tor-S6, Tor-S7 and Tor-S9. Monitoring sites Tor-S1, Tor-S2, Tor-S4 and Tor-S5 measure pollutants and flow leaving the city boundary. The locations of monitoring sites Tor-S1 through Tor-S9 are indicated on Figure 3.1 as S1 through S9.

Table 3.1 Monitoring Sites for the Special Study

Sampling Location Name	Map ID	Description	Primary Land Use	Lat-/ Long-itude	Upstream Storm Drain Name	Diameter (in) and Material
Tor-S1	S1	Located 40 ft north and 80 ft east of the intersection of Plaza Del Amo and Western Avenue. Basin name.	RES	33.82/ 118.31	City	36 RCP
Tor-S2	S2	Approximately 50 ft west of 246th Place and Pennsylvania Avenue intersection.	RES	33.80/ 118.33	City	33 RCP
Tor-S3	S3	Effluent of Walteria Lake, approximately 300 ft west of Hospital Drive and Skypark Drive intersection.	RES	33.81/ 118.35	Walteria Lake	54
Tor-S4	S4	Approximately 210 ft north and 85 ft east of 236th Street and Western Avenue intersection.	RES	33.81/ 118.31	City	9'-2"Wx11'H RCB
Tor-S5	S5	About 25 ft west of intersection of Bani Avenue and 250th Street (two pipes intersect from south and west).	RES	33.80/ 118.33	City	8'-9"Wx9'-7"H RCB
Tor-S6	S6	Approximately 600 ft east of Estates Lane and Crenshaw Boulevard.	RES	33.79/ 118.34	Rolling Hills E.	36 RCP
Tor-S7	S7	About 730 ft south of Rolling Hills Road and Madison Street intersection. Will monitor dry weather flow originating from Rolling Hills Estates.	RES	33.79/ 118.35	Rolling Hills E.	10'x10' RCB
Tor-S8	S8	About 1,000 ft south of 244th Street and Ocean Avenue intersection. Will monitor dry weather flow originating from Rolling Hills Estates.	RES	33.80/ 118.36	Rolling Hills E.	24 RCP
Tor-S9	S9	About 830 ft east and 120 ft south of Paseo de las Tortugas and Vista Montana intersection. Will monitor dry weather flow originating from Palos Verdes Estates.	RES	33.80/ 118.36	Palos Verdes Estates	42 RCP

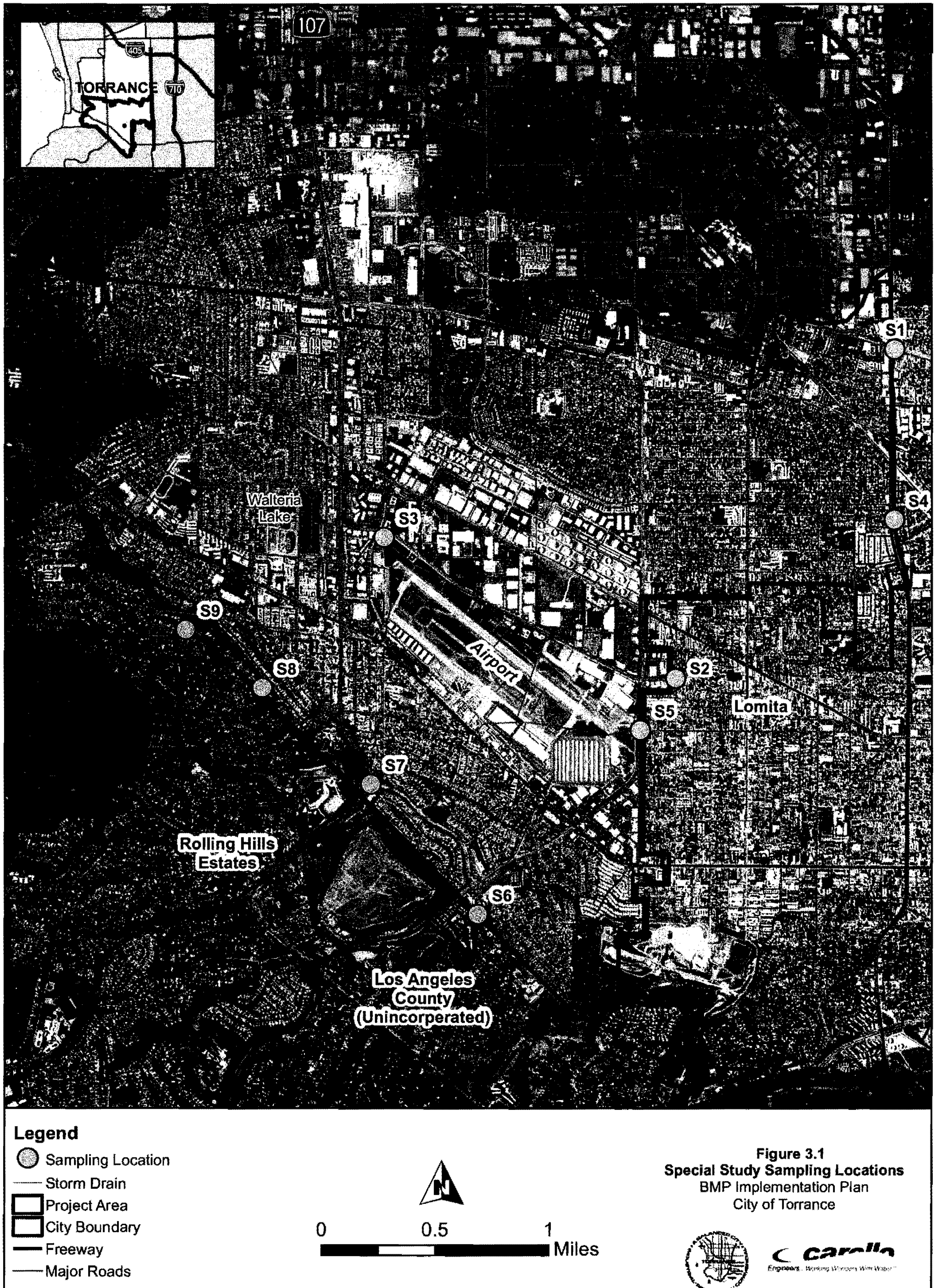


Figure 3.1
Special Study Sampling Locations
BMP Implementation Plan
City of Torrance

Table 3.2 Monitoring Site Drainage Areas and Majority Land Use

Monitoring Site	Map ID (on Figure 4)	Drainage Area (ac)	Predominant Land Use
Tor-S1	S1	154	Residential
Tor-S2	S2	248	Residential
Tor-S3	S3	2,115	Residential
Tor-S4	S4	852	Residential
Tor-S5	S5	797	Residential
Tor-S6, Tor-S7 and Tor-S9 drainage basin outside City of Torrance			

Table 3.3 Total Flow (gallons) and Total Mass (kg) of Nitrogen and Phosphorous

Monitoring Site	Total Annual Flow (Gallons) [1]	Total Nitrogen (kg)	Total Phosphorous (kg)
Walteria Lake Pumping Event (May 29 through June 5, 2012)			
Tor-S3[3]	5,557,715	30.5	4
Total Flow Leaving the City			
Tor-S1	114,947	0.6	0.1
Tor-S2	1,530,700	8.3	1.8
Tor-S4	2,079,514	13	1.5
Tor-S5	79,603,481	3,610	553
TOTAL	**83,328,643**	**3,632**	**557**
Total Flow Entering the City			
Tor-S6	134,162	0.7	0.1
Tor-S7	7,480,023	57	4.8
Tor-S9	1,337,848	6.5	1.6
TOTAL	**8,952,033**	**63.99**	**6.5**
Flow Generated from TMDL Area	**68,818,895**	**3,533**	**546**

Note:
(1) Discharge from Walteria Lake During Pumping (March 7 and December 31, 2012).

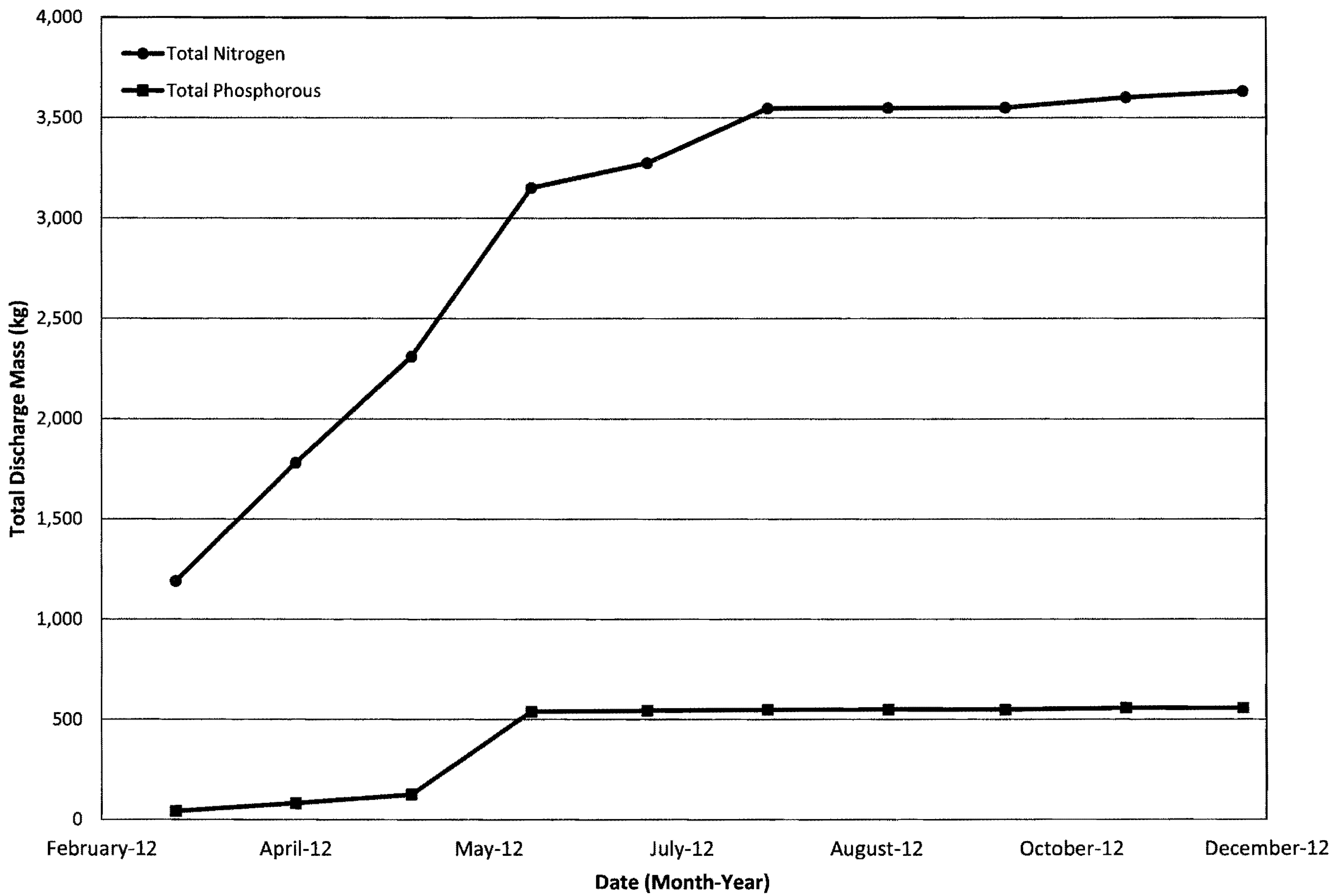


Figure 3.2 - Cumulative Nutrient Load Leaving City Boundary

The water quality sampling data were reviewed to identify whether site location or the timing of events affected the concentrations observed. The data set was reviewed in this way by constituent group, constituent, and, as necessary, constituent fraction (e.g., total and dissolved phosphorus). An analysis of sample variance showed that neither the site location nor event timing had any significant affect on the concentrations of the constituents measured during the study.

3.2 Dry Weather Loading

Dry weather can also be a significant source of pollutant loading. However, results of the stormwater sampling indicate that dry weather flows are insignificant and therefore no further modeling was performed.

3.3 Wet Weather Loading

The City developed a Stormwater Quality Master Plan (SQMP) in 2011 to address increasingly stringent regulatory requirements and stormwater related issues caused by continued development pressure. As part of the SQMP, the portion of the Machado Lake Watershed within the City was modeled utilizing a tool referred to as the Pollutant Loading and Analysis Tool (PLAT), a module linking a number of publicly available models including: USEPA's PLOAD, the Program for Predicting Pollution Particle Passage thru Pits, Puddles, & Ponds (P8),USEPA's SWMM 5.0, and USEPA's SUSTAIN. WMMS and N-SPECT model (Nonpoint Source Pollution and Erosion Comparison Tool) were used to validate PLAT model results. The PLAT was initially calibrated to WMMS model output obtained from the Los Angeles County. PLAT is based mainly on spatially distributed inputs derived from high-resolution satellite imagery.

There are many models that might be suitable for use in conducting the evaluation for Implementation Area. Because Torrance has previously used PLAT as a watershed modeling and basin planning tool, the modeling efforts in the Implementation Area utilized PLAT methodology. In addition, the PLAT modules were selected based on the following model capabilities:

- Dynamic continuous long-term simulation for modeling runoff and pollutant loadings and concentrations in discharges and receiving waters from lands in a watershed system
- Can represent rainfall, runoff , and groundwater processes of urban and natural watershed systems
- Can represent variability in pollutant loadings, based on land use, soil hydrologic group, and slope among other parameters
- Employs a BMP process based approach or empirically based BMP approach

- Includes decision support to evaluate cumulative BMP performance on a watershed scale

3.3.1 Pollutant Loading and Analysis Tool (PLAT)

Even though PLAT was developed before the guidelines (RWQCB, 2014) for developing a Reasonale Assurance Analysis (RAA) was published, only few enhancements were made to meet RAA modeling requirements. The enhancements include converting the original XP-SWMM model (a proprietry software) to EPA SWMM 5.0 model. The general concept of PLAT methodology is presented on Figure 3.3. PLAT methodology is comprised of three main evaluations:

1. Model Calibration/verification – In the absence of field data specific to Torrance, LA County WMMS and N-SPECT models were used to calibrate/validate some modules of PLAT.
2. Annual load estimation and initial BMP Screening. – impervious cover information derived from satellite imagery, event mean concentration (EMC) and PLOAD model were used to compute annual pollutant load, characterize pollutant hotspots, and perform initial BMP screening analysis to select BMPs for detailed aevaluation.
3. Detailed Load and BMP Evaluation – Uses EPA SWMM 5, P8 and SUSTAIN models for comprehensive water quality modeling to identify priority subbasins based on BMP need, BMP sizing and optimization, and evaluation of management alternatives.

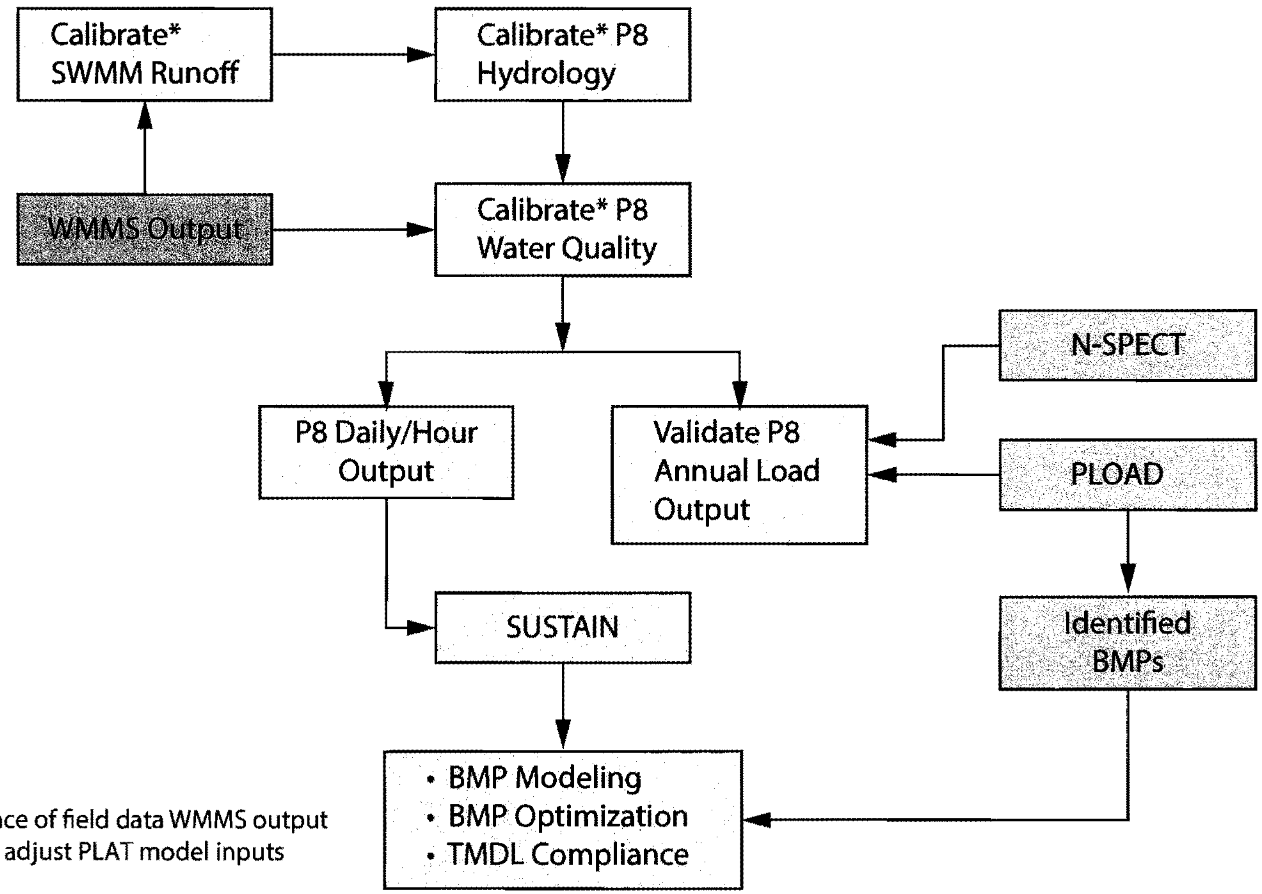
The following paragraphs summarize the modules used in PLAT.

3.3.1.1 Annual Load Estimation and Initial BMP Screening Analysis

Satellite remote sensing imagery is the primary source of data used in this analysis. PLOAD, a spreadsheet model, is among one of the models that is most commonly used to estimate pollutant loadings on an annual average basis for any user-specified pollutant. Impervious cover and land cover information extracted from satellite imagery is used in conjunction with PLOAD to compute annual pollutant load for the TMDL Implementation Area.

3.3.1.1.1 PLOAD

The PLOAD model was originally developed to calculate pollutant loads for urban and suburban watersheds, which was subsequently adopted by the USEPA for watershed management planning and was integrated into the BASINS model (USEPA 2001). PLOAD determines pollutant load from a watershed based on watershed land-use data, percent imperviousness, and pollutant export coefficients or event mean concentrations (EMC) values based on either observed data or available literature. It is commonly used to estimate pollutant loadings on an annual average basis for any user-specified pollutant.



* In the absence of field data WMMS output was used to adjust PLAT model inputs

Figure 3.3 General Concept of PLAT Analysis

However, PLOAD does not have the ability to estimate conveyance, e.g., it cannot evaluate changes in peak flow or water quality due to transport. The model also cannot accurately be applied to assess loading for short time intervals. Unlike other models such as P8, it also cannot be used to locate and size BMPs.

3.3.1.1.2 Satellite Remote Sensing

Satellite remote sensing information provides an effective way for monitoring land use/land cover changes in urban areas through mapping variations in anthropogenic impervious surfaces. Impervious surface area (ISA) is considered a key indicator of environmental quality and is also used to identify extent of urban land use because it is highly related to urban land use categories and development density (Xian and Crane, 2005). In addition, ISA can be measured fast and economically by using multi-temporal satellite remotely sensed information. The longtime records available from land remote sensing data makes it possible to quantitatively estimate spatial and temporal variations of land use/cover conditions.

Ground surveys are expensive and generally not practical for mapping impervious surfaces of large areas such as the City's service area. While Global Positioning System (GPS) is useful for assisting in collecting field data, it is not easily implemented for mapping large areas either. Remote sensing, in the form of aerial photography, has been an important source of land use-land cover information for many years and impervious surface area can be readily interpreted from aerial photographs (Draper and Rao, 1986). However, the cost of aerial photography acquisition and interpretation of cover types is prohibitively expensive for large geographic areas. An alternative is to acquire the needed information from digital satellite imagery such as the Landsat Thematic Mapper or Enhanced Thematic Mapper Plus, WorldView, IKONOS, and QuickBird. This approach has several advantages:

1. The synoptic view of the sensor provides large area coverage,
2. The digital form of the data lends itself to efficient analysis,
3. The classified data are compatible with geographic information systems (GIS), eliminating the need to digitize interpreted information, and
4. Land cover maps can be generated at considerable less cost than by other methods.

A number of studies have demonstrated the feasibility of using multispectral satellite data to classify impervious surface area in urban environments. In this study, a high-resolution WorldView satellite imagery acquired on July 10, 2010 was used for ISA mapping.

DigitalGlobe's WorldView-2, the world's newest high-resolution commercial color imaging satellite, was launched on October 8, 2009 from Vandenburg Air Force Base in California. WorldView-2 is the first high-resolution satellite with 8-multispectral imaging bands. It can simultaneously collect panchromatic imagery (black and white) at 0.46 m grid resolution and multispectral imagery at 1.84 m grid resolution. The satellite provides full-color images for enhanced spectral analysis, mapping and monitoring applications, land-use planning, disaster relief, exploration, defense and intelligence, and visualization and simulation environments. The combination of WorldView-2's increased agility and high altitude enables it to typically revisit any place on earth in 1.1 days.

3.3.1.1.3 Impervious Surface Area Mapping

Impervious area was determined based on satellite imagery. As part of this project, the City purchased high-resolution satellite data from WorldView captured on July 10, 2010. The imagery was selected to minimize the impact of cloud cover and atmospheric effects. The imagery was geometrically and radiometrically corrected using standard methods. Terrain correction using the USGS 1-arc second National Elevation Dataset was performed to improve geolocation accuracy. The geo-rectified satellite imagery is shown in Appendix C.

An image processing model was developed whereby impervious surfaces were extracted from the imagery based on user-defined variables. Within the study area, five image samples, distributed throughout the watershed and encompassing all general land uses were input to the model. Each of the sample images were classified as either pervious or impervious cover. The output was put into GIS for further analysis.

A ground-truth dataset was created by generating a stratified random sample of points across the study area and classifying the points as either pervious or impervious. This step was accomplished via photo interpretation of current high-resolution vertical and oblique color aerial photography.

The completed impervious cover map after image classification and statistical analysis is shown on Figure 3.4. The percentage of impervious surface area is depicted as a continuous variable, ranging from 0 to 100 percent imperviousness based on redness. Areas shaded in deep red have the highest percentage of imperviousness, while areas shaded in light pink have the lowest percentage of imperviousness. Figure 3.5 shows the average percent subbasin imperviousness derived from Figure 3.4.

To confirm that satellite imagery can be used to accurately classify the percent impervious surface area, the satellite estimates were compared to measurements made from aerial photographs provided by the City. The location where the comparison was made is shown on Figure 3.4. Figure 3.6 shows the correlation between the percent imperviousness between these two sources. The results indicate that there is a strong relationship between aerial photograph measurements and satellite-derived estimates. Based on the comparison, an impervious cover map was created using satellite imagery for the entire study area.

Imperviousness (%)

High : 100

Low : 0

% Impervious Comparison Area

Figure 7
Percent Impervious Cover Map Derived from World View 2 Satellite Imagery
BMP Implementation Plan
City of Torrance

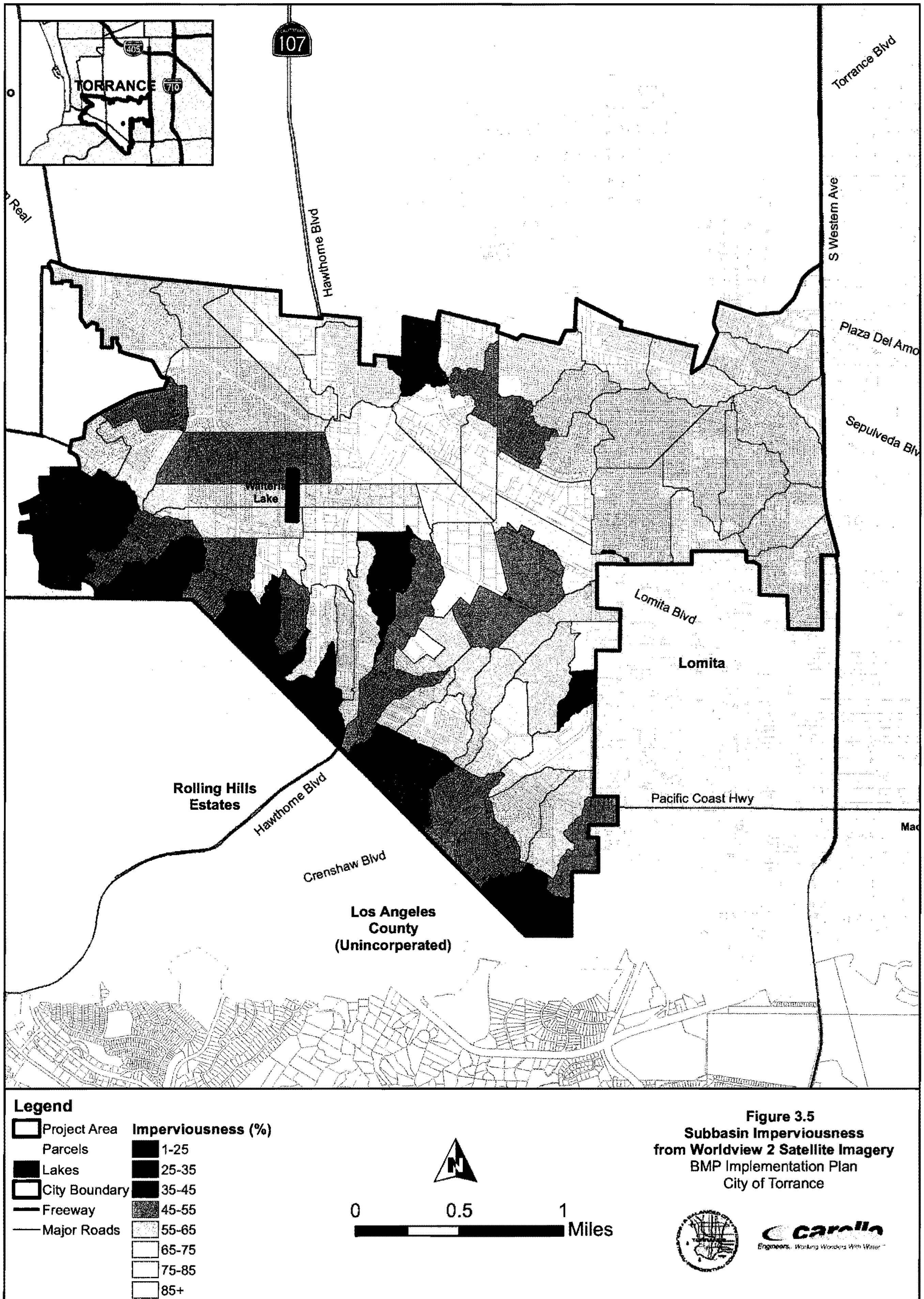


Figure 3.5
Subbasin Imperviousness
from Worldview 2 Satellite Imagery
BMP Implementation Plan
City of Torrance

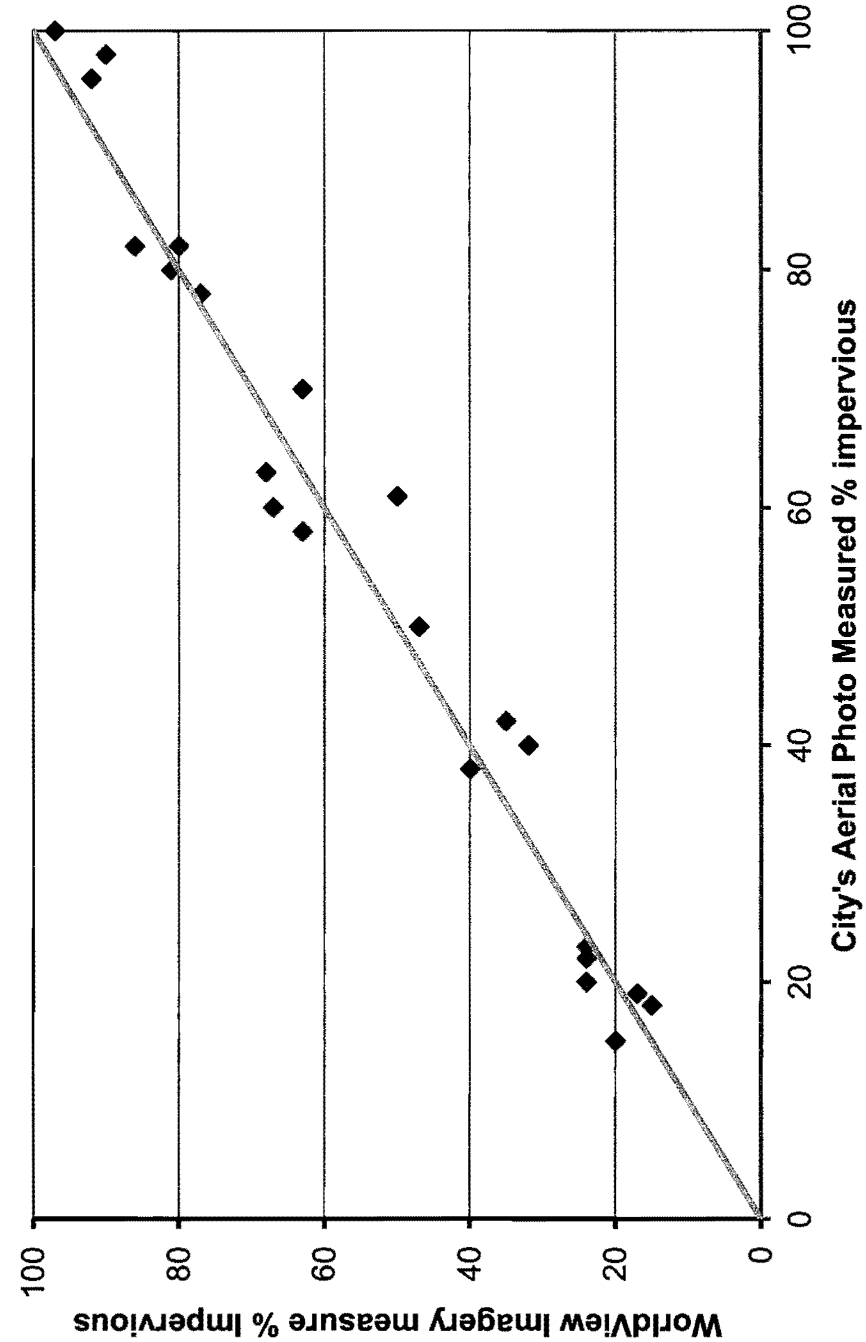


Figure 3.6 - Percent Imperviousness Comparison - Aerial Photo vs Satellite Imagery

3.3.1.2 PLAT Detailed Load and BMP Evaluation Modules

The main objective of the Detailed BMP Evaluation is to overcome the limitations of PLOAD. The Detailed BMP Evaluation modules use the results of the initial BMP Screening by PLOAD to limit computational time by avoiding modeling BMPs that may not work.

Under the current PLAT structure, subcatchment hydrology must be simulated externally. For this project, an external surface water management model (SWMM 5.0) was developed to simulate hydrographs for the study basins, and these hydrographs were subsequently imported into the P8 and SUSTAIN models. The City's original XP-SWMM model was exported to SWMM 5.0 for use in this analysis to meet RAA modeling requirement. This section describes the linkages between the SWMM, P8 and SUSTAIN models, and provides a step-by-step process of the modeling methodology.

The general steps for model development and calibration are listed below and illustrated on Figure 3.7.

1. Converted XP-SWMM model EPA SWMM 5.0 model to simulate runoff and routing for study basins.
2. Calibrated SWMM model runoff volume and timing to flow data extracted LA County WMMS model .
3. Using the calibrated SWMM model, developed unit-area surface water hydrographs (not including stream baseflow) to characterize runoff from each subcatchment by land use (commercial, residential, or forest) and land cover (pervious or impervious) for the 1-year calibration period.
4. Developed unit-area pollutographs for the calibration period by applying event mean concentrations (EMCs) from each land use to the unit-area hydrographs (not including stream baseflow).
5. Built P8 and SUSTAIN land and conveyance module using unit-area hydrographs, pollutographs, and calibrated routing parameters from the SWMM model for the 1-year calibration period.
6. Confirmed flow calibration was maintained by comparing runoff files from calibrated SWMM model to those from P8 and SUSTAIN.

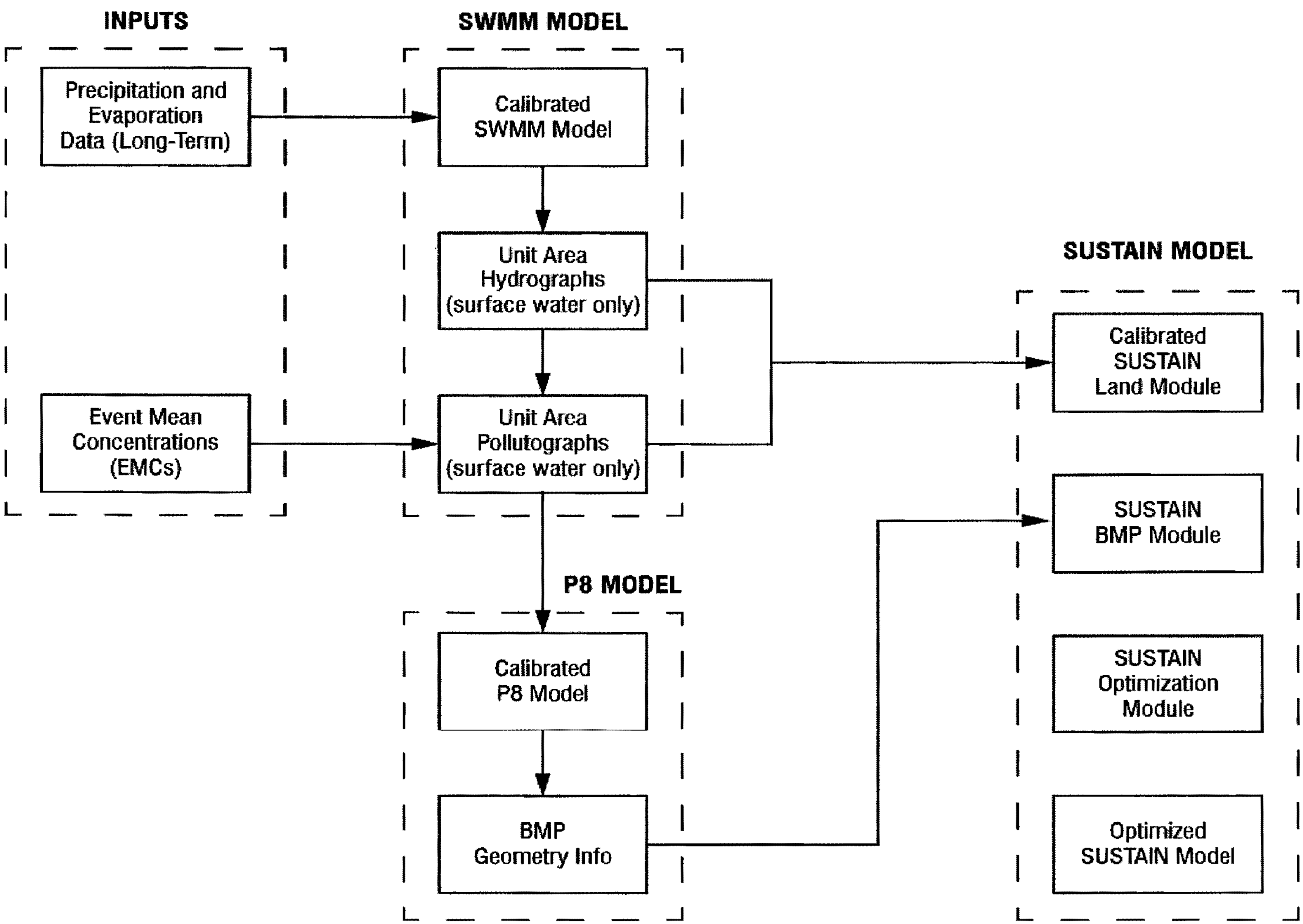


Figure 3.7 SWMM, P8 and SUSTAIN Model Development and Calibration/Verification

3.3.1.2.1 EPA SWMM 5.0

The original XP-SWMM model runoff volume and timing was calibrated to one year flow data extracted from WMMS. XP-SWMM is not a public domain software and therefore the model will be converted to EPA SWMM 5.0. The conversion will not result in any significant loss of accuracy since they computationally use similar engines. EPA SWMM 5.0 (SWMM) is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from user-prescribed land uses. SWMM has been widely used, since its initial development in 1971. GIS is used for the spatial component of the analysis in addition to visualization.

Infiltration was simulated in the SWMM 5.0 model using the Horton Infiltration equation. This equation is used to represent the exponential decay of infiltration capacity of the soil that occurs during rainfall or snowmelt events. The soil infiltration capacity is a function of the following variables: Fo (maximum or initial value of infiltration capacity), Fc (minimum or ultimate value of infiltration capacity), k (decay coefficient), and time. These infiltration parameters are used for the generation of runoff from the individual sub-drainage basins.

The actual values of Fo, Fc, and k are dependent upon soil, vegetation, and initial moisture conditions prior to a rainfall or snowmelt event. Because it was not feasible to obtain this detailed information for each sub-drainage basin through field samples, infiltration assumptions were made based on the soil types throughout the study area. Composite infiltration parameters (Fo and Fc) were calculated for each sub-drainage basin based on the fraction of each soil type within each individual sub drainage basin. Global databases containing the infiltration parameters for each sub-drainage basin were developed and imported into the SWMM 5.0 model.

The values of Fo, Fc, and k applied for each Hydrologic Soil Group are summarized in Table 3.4. The values shown in the table are based on suggested values in the *Storm Water Management Model, Version 4: User's Manual*, U.S. EPA, 1988. The Fo and Fc values were determined for each sub-drainage basin by calculating a weighted average based on the given soil groups within each basin.

Table 3.4 Horton Infiltration Parameters

Hydrologic Soil Group	F_o (in/hr)	F_c (in/hr)	k (1/sec)
A	5.0	0.38	0.00115
B	3.0	0.23	0.00115
C	2.0	0.10	0.00115
D	1.0	0.03	0.00115

3.3.1.2.2 P8 - Urban Catchment Model

The P8 model is designed to predict the generation and transport of runoff pollutants in urban watersheds. It consists mainly of methods derived from other tested urban runoff models, including SWMM, HSPF, D3RM, and TR-20.

The P8 model was developed to design and evaluate development runoff treatment control combinations for pollutant removal efficiency. Although, due to its simplicity, the P8 model has inherent limitations, this model is highly suitable for planning level studies and scenario testing. Model components include stormwater runoff assessment, surface water quality analysis, and routing through structural controls. The model applications include development and comparison of stormwater management plans, watershed-scale land-use planning, site planning, and evaluation for compliance, effectiveness of BMPs, and selection and sizing of management practices.

In P8, continuous water balance and mass balance calculations are performed on a user-defined system consisting of watersheds, devices (runoff storage/treatment areas, BMPs), particle classes, and water quality components. Simulations are driven by continuous hourly rainfall and daily air temperature time series data. The model simulates pollutant transport and removal in a variety of BMPs, including swales, buffer strips, detention ponds (dry, wet, and extended), flow splitters, and infiltration basins (offline and online), pipes, and aquifers.

3.3.1.2.3 SUSTAIN

To overcome the limitations of P8, the SUSTAIN model is employed to comprehensively size and place BMPs, perform optimization analysis, and assess TMDL compliance. Input for SUSTAIN is derived by P8 and SWMM.

The SUSTAIN model is public domain software developed by USEPA. SUSTAIN includes algorithms for simulating urban hydrology, pollutant loading, and treatment processes packaged from multiple models that individually address such processes. Users have the option to import time series data from external watershed models (e.g., Hydrologic Simulation Program Fortran (HSPF) or SWMM instead of performing new land simulations in SUSTAIN.

3.3.1.3 Model Calibration/Verification

In the absence of field data specific to Torrance, LA County WMMS and N-SPECT models were first used to calibrate and validate some modules of PLAT. Annual load computed by PLOAD and P8 modules were compared to WMMS and N-SPECT output.

The Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT) is a complex yet user-friendly geographic information system (GIS) extension that helps coastal managers and local decision makers predict potential water-quality impacts from nonpoint source pollution and erosion. Input data includes land cover, elevation, precipitation, and soil characteristics to create the baseline information.

3.3.2 Average Annual Wet Weather Load

The annual average loadings generated by PLAT for each sub area in the TMDL Implementation Area are presented in Table 3.5. The data used in the model represent general observations in the Los Angeles Harbor/Dominguez Channel Watershed, which includes the Machado Lake subwatershed, and specific monitoring data from the TMDL Implementation Areas. Monitoring conducted as per the TMDL requirements was used to refine the PLAT modeling results in the Machado Lake watershed, as appropriate.

Table 3.5 PLAT Annual Average Loads by Sub Area

Sub Area	Area[1] (ac)	TSS (kg/yr)	TN (kg/yr)	TP (kg/yr)	Toxics (g/yr)
Baseball Field	155	15,650	28	4	1.19
Walnut Sump	923	71,451	127	22	5.44
Walteria Lake[2]	2,118	2,989	38	7	0.23
Airport	975	72,305	4,168	619	5.51
Airport Southeast	70	2,897	4	0.9	0.22
Total	**4,241**	**165,292**	**4,365**	**653**	**12.59**

Notes:
(1) Area from PLAT
(2) Load entering Airport Sub Area

3.4 Summary of Sources

The information about pollutant loading from the TMDL Implementation Area in the Machado Lake watershed can be compared with the TMDL allocations. A summary of the pollutant loading from the TMDL Implementation Area, the Final TMDL allocations and ultimate required reductions are presented in Table 3.6.

The annual loading from the TMDL Implementation Area currently complies with the interim limit of total nitrogen, 7,370 kg/yr and total phosphorus of 3,760 kg/yr as listed in Table 3.6 of this report. Final nutrient WLAs are supposed to be attained by September 11, 2018.

According to Table 3.6, 54 percent of total phosphorus load and 31 percent of total nitrogen load must be removed by the City to meet the final nutrient WLAs.

Table 3.6 Calculated Annual Loading Rates to Machado Lake

Constituent	Annual Loading(1) (kg/yr)	Final Allocation (kg/yr)	Required Reduction (kg/yr)	Required Reduction(2) (%)
Total Nitrogen	4,365	3,008	1,357	31
Total Phosphorus	653	301	352	54
Toxics Constituent	**Annual Loading(1) (g/yr)**	**Final Allocation (g/yr)**	**Required Reduction (g/yr)**	**Required Reduction(2) (%)**
Total PCBs	10.74	9.88	0.00	8
Total DDT	0.83	0.87	0.00	0.0
Dieldrin	0.66	0.54	0.12	18
Chlordane	0.36	0.31	0.05	14

Notes:
(1) The annual loading from the TMDL Implementation Area complies with the interim limit of total nitrogen, 7,370 kg/yr and total phosphorus of 3,760 kg/yr as listed in Table 3.
(2) Percent of pollutant amount that is required to be removed.

3.5 Pollutant Source Characterization

The locations and density of pollutant sources in the TMDL Implementation Area are keys to understanding where BMPs and other implementation components should be focused. Typical sources for the pollutants of concern (nutrients) are fertilizers (residential and agricultural), atmospheric deposition, wastewater, leaking sewers, septic systems, animal operations, pets, native geology. The following sections provide a description of these sources.

3.5.1 Sanitary Sewer and SSOs

When sanitary sewers overflow or leak, they can release raw sewage into the environment. Many sanitary sewer networks in the United States were installed decades ago and are in need of replacement. Aging systems are a major source of sanitary sewer leakage. Severe weather, improper system operation and maintenance (O&M), clogs, and root growth can contribute to sanitary sewer leaks and overflows. Overflows can affect nearby waters and also back up into streets and basements (USEPA 2009). Raw sewage contains high concentrations of bacteria and nutrients from human and kitchen waste, as well as organic chemicals and metals.

Chemicals are present in sewage water from household use of cleaners, disinfectants, personal care products, treated swimming pools, and pharmaceuticals. Personal care products and pharmaceuticals have recently been scrutinized for their potential to be harmful endocrine disrupting chemicals (Boyd et al. 2004). Chemicals from laboratory sinks are also present in raw sewage (USEPA 2009).

3.5.2 Agricultural Operations

Agricultural land use is limited in the TMDL Implementation Area and therefore are not a significant source of nutrients.

3.5.3 Atmospheric Deposition

Atmospheric deposition of pollutants—either directly to a waterbody surface or indirectly to the watershed land surface—can be a large source of contamination to surface waters near urban centers. While this atmospheric source ultimately becomes a part of stormwater, it is important to understand the pathways from initial source (e.g., industrial facility emitting metals into the air) and transport (from air to land to water) processes. Direct dry deposition to waterbodies in the TMDL Implementation Area is not a significant factor because of the small water surface on which to receive direct deposition. Pollutants also exist in wet deposition, which occurs during rain and snowfall. In California, wet deposition is not a significant source of pollutants in comparison to dry depositions because there are so few rain events (Lu et al. 2003).

3.6 Pollutant Source Prioritization

To help develop implementation strategies, a prioritization of pollutant loading by sub area and potential sources was developed. The effort is concentrated on wet weather loading, with the assumption that BMPs targeted for the watershed would be designed to treat both wet and dry weather flows that drain to the BMP.

Wet weather loads generated from the TMDL Implementation Area were converted to area loads (e.g., pounds per acre per year [lb/ac/yr]) for use in the pollutant source prioritization. This provides a normalized view for targeting management in that it shows where the rates are highest. Area loads for each constituent were then ranked with a score 1 through 4 by sub area. Values were assigned quartiles as follows:

- A score of 1 for the lowest 25th quartile[1],
- A score of 2 for values between the 25th and 50th quartile,
- A score of 3 for values between the 50th and 75th quartile, and
- A score of 4 for the highest quartile.

The final rankings for wet weather area-based loads in Table 3.7.

[1] A quartile is one of the 4 subdivisions that have been grouped into four equal sized sets based on their statistical rank.

Table 3.7 Wet Weather Load Ranking by TMDL Implementation Area (Area Loads)					
TMDL Implementation Area	Parameter Score			Total Score	Priority Rank
	TSS	TN	TP		
Airport	4	4	4	12	1
Walnut Sump	4	2	3	9	2
Baseball Field	3	3	3	9	2
Airport Southeast	1	2	2	5	3
Walteria Lake	2	1	1	4	4

Rank: 1 – Highest Priority 4 – Lowest Priority

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4.0 DEVELOPMENT OF NONSTRUCTURAL SOLUTIONS

The Implementation Plan uses an integrated approach to address multiple pollutants, using both structural and nonstructural solutions. The following are the proposed nonstructural BMP opportunities to control the contribution of pollutants to the maximum extent practicable.

A comprehensive program has been developed and ready to be implemented to reduce or eliminate the amount of pollutants in stormwater and urban runoff. This program meets a variety of regulatory requirements, including those of the LARWQCB adopted Order R4-2007-0042 for municipal stormwater and urban runoff discharges within the County (LARWQCB 2007b). An evaluation was conducted to identify opportunities for improvements to existing programs and new programs that would help meet TMDL WLAs and to determine the level of success in implementing these programs. Existing nonstructural BMPs are described in Section 4.1.1 and new nonstructural BMPs are proposed in Section 4.1.2. Considered holistically, these existing, improved, and new programs are expected to contribute to the reduction of TMDL pollutant loads and contribute to meeting WLAs.

4.1 Nonstructural Solutions

In general, nonstructural solutions include pollution prevention actions and source control activities that prevent or minimize the amount of pollution entering urban runoff. Pollution prevention actions seek to control constituents of concern before their release to the environment. Typical pollution prevention actions include conservation and reuse activities. Source control activities target pollutants from specific sources to reduce or eliminate the concentrations of those pollutants entering the municipal separate storm sewer systems (MS4). Typical source control activities include, but are not limited to:

- Issuance of local ordinances
- Street sweeping
- Product bans by either the State or Federal government

For pollution prevention and source control measures to be effective, the parties involved need to be educated about the measures, incentives should be provided to use the measures, and enforcement should be available to ensure the measures are implemented. Both pollution prevention and source control measures are proposed as complementary components of nonstructural solutions, which may provide more effective treatment at a lower cost than many structural solutions.

4.1.1 Existing Nonstructural BMPs

The following provides a summary of existing nonstructural BMPs that were evaluated to determine if enhancements could be made to specifically support TMDL implementation. A summary of the City's existing nonstructural BMPs relevant to nutrients and sediment reduction and flow reductions are presented in Table 4.1. The description provides an overview of relevant programs that could directly support stormwater pollution control.

Table 4.1 Ongoing Nonstructural Solutions Conducted by City of Torrance

Non-structural Solution	BMP Type	Description
Public Information and Participation Program	Education	Encompasses several outreach campaigns. Those that most directly address nutrients are the Smart Gardening Program, pet waste outreach, and fats, oils and grease outreach.
Industrial/ Commercial Facilities Control Program	Enforcement	Tracks, inspects, and ensures compliance with permits for industrial and commercial facilities. Controls pollutant transport.
Development Planning	Source Control	Focuses on mitigating the long-term hydrologic and pollutant effects of the built environment and changes in land use. Includes establishing requirements for post-construction BMPs, reviewing plans to ensure that proposed drainage plans meet water quality and hydrologic performance standards, and ensuring long-term operation and maintenance of post-construction BMPs.
Development Construction Program	Enforcement	Addresses runoff from public and private construction projects through the use of stormwater pollution prevention plans (SWPPPs), training of staff engaged in construction activities, and compliance inspections. Through runoff prevention, controls the transport of nutrients and toxics.
Public Agency Activities Program	Source Control	Applies BMPs to infrastructure and facility operation and maintenance activities of Public Agencies to reduce pollutant sources. This includes sewer system maintenance, corporation yard, and recreational facility management.
Illicit Connections/Illicit Discharge Program	Enforcement	IC/ID removal prevents the discharge of a variety of pollutants including nutrients and toxics from entering the storm drain system.
Catch Basin Clean Out	Source control	Catch basins are cleaned at least annually, with higher priority catch basins cleaned semi-annually or quarterly. For industrial catch basins, the optimal cleaning frequency appears to be between quarterly and semiannual; for residential catch basins, the optimal frequency appears to be annual. For commercial catch basins, the optimal frequency is semiannual.
Catch Basin Inserts[1]	Source Control	In an effort to reduce trash as part of the Machado Lake Trash TMDL, catch basin inserts could be installed in portions of watershed. Catch Basin Inserts proposed with Machado Lake Trash TMDL Project.

Table 4.1 Ongoing Nonstructural Solutions Conducted by City of Torrance		
Non-structural Solution	**BMP Type**	**Description**
Street Sweeping	Source Control	Curbed streets are swept weekly with vacuum sweepers in the city. Much of Torrance is not signed for street sweeping. This will be corrected with Machado Lake Trash TMDL Project.
Impervious Cover Disconnection	Source Control	Employ rooftop disconnection techniques.
County Ordinance No. 2008-000S2U	Enforcement	Prohibits wash down of paved surfaces, irrigation runoff, and requires car washing BMPs.
Restaurant Training	Education	An education program that includes restaurant BMP guidelines, a watershed model showing the potential for oil and grease to affect the watershed, a PowerPoint presentation, and collateral material for restaurant owners, including posters, buckets with BMPs printed on them, and brochures. Torrance does this as part of Clean Bay Certification Program.
County Ordinance Title 10 Animals, Chapter 10.40.060, B.	Enforcement	Requires pet owners to pick up and properly dispose of their pet's waste.

Notes:

(1) Although normally considered structural BMPs, for the purposes of the model, catch basin inserts were accounted for as a nonstructural BMP

(2) Torrance has ban on smoking in Public Parks and Torrance Beach.

Enhancements to the existing nonstructural BMPs and additional nonstructural BMPs can be considered and are discussed in the following section.

4.1.2 Potential Nonstructural BMPs

Potential nonstructural BMPs may include new nonstructural solutions and enhancements of existing nonstructural solutions. Specific sources of nutrients and toxics and their associated nonstructural solutions are listed in Table 4.2. The nonstructural solutions listed in Table 4.2 are detailed in Table 4.3. Sanitary sewer maintenance is covered in other areas of the Implementation Plan. Note that the costs presented in Table 4.3 are per year, and total implementation costs include an estimated rate of inflation of 3 percent over the life of the program.

Table 4.2 Potential Nonstructural Solutions by Pollutant Source

Pollutant Source	Associated Potential Nonstructural Solution(s)
Irrigation overflow	• Smart Gardening Program, with evapotranspiration controller irrigation enhancement • Public Agency Activities Program – landscape and recreational facilities management focus
Landscape fertilizer	• Smart Gardening Program • Public Agency Activities Program – landscape and recreational facilities • management focus • Development Planning – post construction BMPs
Catch basins[1]	• Development Planning – post construction BMPs • Catch basins[1] • Catch basin clean outs – increased frequency • Catch basin inserts – install inserts where other structural BMP retrofits options are infeasible due to ownership/space constraints. Inserts should be selected that are capable of removing nutrients.
Streets and parking lots	• Street and parking lot sweeping – more efficient sweepers and increased frequency
IC/ID	• More aggressive identification and removal of illicit connections
Sewage	• Add stencils and re-stencil storm drains, as needed • Public Agency Activities Program – sewer systems maintenance, overflow, and spill prevention focus • Public Information and Participation Program – fats, oils, and grease outreach • Recreation Vehicle Sewage Disposal Sites – Public Information
Horse manure	• Public outreach
Pet waste	• Public outreach, providing bags and receptacles at parks, etc.
Green waste	• Public outreach
Sediment	• Industrial/Commercial Facilities Control Program • Development Planning • Public Agency Activities Program – materials storage facilities/corporation yards management focus

Note:
(1) Although normally considered structural BMPs, for the purposes of the model, catch basin inserts were accounted for as a nonstructural BMP

Table 4.3 Proposed New and Enhanced Non-Structural BMP Descriptions

Non structural Solution	Description	New/Enhanced Program	Targeted Pollutant	Annual Cost
Add stencils and re-stencil storm drains, as needed	Audit storm drains to determine where stencils are not present or are faded. Efforts should initially be focused in Island 1 where field investigations noted faded or missing storm drain labels	Enhanced: Public Agency Activities Program	Nutrients and toxics	$5K per year
Catch basin clean outs	Modify program to use more aggressive techniques and increase frequency to clean 60% of catch basins monthly and 40% of catch basins semi-annually.	Enhanced: Public Agency Activities Program	Nutrients and toxics	$100K per year
Catch basin inserts[1]	Expand installation of trash catch basin inserts to cover more areas in the city; catch basin inserts should be capable of removing trash, nutrients, and toxics. As an example, Kristar's FloGard Perk Filter has been approved by Washington Dept of Ecology's TAPE program 5 as "basic treatment" meaning that third party monitoring data has validated its ability to remove at least 80% TSS and 50% TP. Regular maintenance is necessary to retain pollutant removal performance	Enhanced: TMDL Implementation	Nutrients and toxics	$20K (includes yearly O&M)
Downspout disconnection program	Establish a downspout disconnection program to incentivize the disconnection of residential rooftop downspouts. See Section on Integrated Water Resource Considerations for additional information, page 36	New	Nutrients and toxics	$50K/ year
Fats, oils, and grease outreach	Target restaurants and residents in the TMDL Implementation Area for additional FOG outreach to educate them about the potential of sewage overflows caused by FOG blockages	Enhanced: PIPP	Nutrients	$5K/ year
Green waste outreach	Target residents and institutional land uses in TMDL Implementation Area for additional proper management of green waste.	New	Nutrients	$5K/ year

Table 4.3 Proposed New and Enhanced Non-Structural BMP Descriptions

Non structural Solution	Description	New/Enhanced Program	Targeted Pollutant	Annual Cost
Horse manure outreach	Target residents for outreach about horse manure management.	New	Nutrients	$5K/ year
Illicit connection removal	Enhance program so that 40% of the system is surveyed and 20% of identified IC is removed	Enhanced: ID/IC Program	Nutrients and toxics	$75K $2,500/illicit connection removal[2]
Industrial/ Commercial Facilities Control Program	Enhancement may include more in-depth training for inspectors and staff that addresses nutrient and toxics specific BMPs. Strengthening partnerships with enforcing agencies may also improve enforcement escalation procedures	Enhanced: Industrial Commercial Facilities Program	Nutrients and toxics	$5K/ year
Landscape and recreational facilities management	Enhancements are similar to the Smart Gardening Program, with application to landscape and recreational facilities managed by the City. The enhancements include switching to non-phosphorus organic fertilizers or using no fertilizer, adding soil amendments to lawns, converting a goal of 25% of lawn to native vegetation and using ET controllers. Outreach may include trainings for City staff that manage or maintain landscape and recreational facilities	Enhanced: Public Agency Activities Program	Nutrients and toxics	$10K/ year
Materials storage facilities/ corporation yards management	Training for City staff in charge of materials storage facilities and corporation yards with focus on activities and materials that may contribute to nutrient and toxic pollution to storm drain	Enhanced: Public Agency Activities Program	Nutrients and toxics	$5K/ year
Oil pump ESC outreach	Work with oil pump parcels located throughout the TMDL Implementation Area to ensure that sediment does not leave the site during the wet season.	New	Nutrients and toxics	$10K/ year
Pet waste outreach	Target residents, pet stores, and animal shelters in TMDL Implementation Area for additional pet waste outreach	Enhanced: PIPP	Nutrients	$50K/ year

Table 4.3 Proposed New and Enhanced Non-Structural BMP Descriptions

Non structural Solution	Description	New/Enhanced Program	Targeted Pollutant	Annual Cost
Post construction requirements for new development and redevelopment	This program may be enhanced with additional training for Development Planning Staff. The focus would be education in planning for and maintaining post-construction BMPs that are effective in reducing nutrients toxics, and runoff	Existing: Development Planning Program	Nutrients and toxics	$25K
Sewer system maintenance, overflow, and spill prevention	Enhance sewer system maintenance and target staff working in the TMDL Implementation Area for SSO response and spill prevention training.	Enhanced: Public Agency Activities Program	Nutrients	$20K • $1,700/mi to clean sewer pipe
Smart Gardening Program	This program includes outreach to reduce inputs (fertilizers, pesticides, water, etc.) to landscape, controlling nutrient sources and irrigation runoff. Field investigations showed evidence of lawn irrigation runoff in the majority of residential neighborhoods in all three Islands. This program should aggressively target the population within the TMDL Implementation areas. This program may be additionally enhanced to include evapotranspiration (ET) controllers to further reduce irrigation runoff. It may also encourage residents to change to non-phosphorus organic fertilizers or use no fertilizer, add soil amendments to lawns, and convert lawn to natural vegetation.	Enhanced: Public Agency Activities Program	Nutrients and toxics	$60K/ year
Street and parking lot sweeping	Increase frequency of sweeping to 2x/weekly	Enhanced: Public Agency Activities Program	Nutrients and toxics	$80K/ year4

Notes:
(1) Although normally considered structural BMPs, for the purposes of the model, catch basin inserts were accounted for as a nonstructural BMP.
(2) Source: Marcoux, 2004 and Brown et al., 2004
(3) Source: WERF, 1997
(4) Source: Modified from Ramsey-Washington Metro Watershed District, 2005.
(5) Source: Washington State Department of Ecology's Technology Assessment Protocol - Ecology (TAPE) program reviews performance evaluation reports on new stormwater treatment technologies and determines whether or not the technologies meet Ecology's performance standards. http://www.ecy.wa.gov/programs/wq/stormwater/newtech/

4.2 Public Information and Participation Program

The County of Los Angeles Department of Public Works' Countywide Stormwater/Urban Runoff Public Education, Used Motor Oil and Used Oil Filter Recycling, Household Hazardous Waste/Electronic Waste Collection, and Smart Gardening programs help achieve the Public Information and Participation Program (PIPP) public outreach mandates and address nutrients and toxics pollution. Public community events, paid media campaigns, media relations efforts, and distribution of collateral materials are part of the standard public outreach practices for the above-mentioned environmental education programs. Visit www.CleanLA.com for information about these programs.

The Smart Gardening Program consists of learning centers and workshops that educate homeowners about conservation (of fertilizers, pesticides, water, etc.) when gardening and landscaping, which reduces the amount nutrients and toxics in the environment. The Smart Gardening Program could be enhanced to help facilitate TMDL implementation by identifying learning centers and/or holding workshops in TMDL Implementation Area.

Tip cards with Smart Gardening Program information could be tailored to address specific concerns (discontinuing irrigation overspray as a pollutant transport mechanism, controlling excess nutrients from fertilizer, pesticide alternatives, etc.) and sent to residences within TMDL Implementation Area.

4.3 Nonstructural Solutions Recommendations

As a result of the review of the existing programs that address the TMDL pollutants, the following are recommended enhancements and additional BMPs that would offer additional water quality benefits and contribute to TMDL implementation:

- **Enhancing the Smart Gardening Program** so it would extend the reach of the water conservation and pollution-prevention messages to the Machado Lake watershed.
- **Conducting TMDL-specific stormwater training** that emphasizes activities and BMPs that can cause or mitigate the TMDL pollutants of concern.
- **Enhancing commercial and industrial facility inspections** to avoid that activities associated with these businesses become new sources of pollutants.
- **Improving enforcement escalation procedures** to more effectively address known sources of pollution.
- **Improving street sweeping technology** to more effectively reduce sediment-bound pollutants from road surfaces.
- **Reducing irrigation return flow** through a variety of water conservation initiatives.

The remainder of the discussion and analysis pertaining to nonstructural solutions focuses on those seven recommended BMPs, which are expected to contribute substantially to reductions in pollutant loads. Table 4.4 shows the extent to which each BMP enhancement or new BMP addresses the TMDLs. All the proposed BMPs address nutrients and toxics; TMDL-Specific Stormwater Training addresses trash.

Table 4.4 Summary of Recommended Nonstructural Solutions

	Condition		TMDL Pollutant Addressed		
Nonstructural BMP	**Wet Weather**	**Dry Weather**	**Nutrient**	**Trash**	**Toxics**
Enhancements to Existing BMPs					
Smart Gardening Program Enhancements	√	√	◗	○	◗
TMDL-Specific Stormwater Training	√	√	◗	◗	◗
Enhancement of Commercial and Industrial Facility Inspections	√	√	◗	○	◗
Enforcement Escalation Procedures	√	√	◗	○	◗
Improved Street Sweeping Technology	√	√	◗	○	◗
New BMP					
Reduction of Irrigation Return Flow	√	√	●	○	◗
√ - applicable; ◗ - about half as effective, ○ - effective					

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5.0 DEVELOPMENT OF STRUCTURAL SOLUTIONS

Meeting WLAs for the TMDL Implementation Area will take advantage of the nonstructural BMPs, but structural solutions will provide the majority of the necessary load reductions required. However, structural BMPs are also the most costly, so careful consideration was made in identifying opportunities for structural BMPs and collecting appropriate information to make cost-effective decisions regarding implementation.

Identification and assessment of opportunities for structural BMPs were focused on publicly owned land in the TMDL Implementation Area. Both distributed and centralized structural BMPs were considered. Distributed structural BMPs refer to those practices that provide the control and/or treatment of stormwater runoff at the site level. Typical BMPs in this category include, but are not limited to the following:

- Porous pavement
- Grassed swales
- Bioretention
- Water-harvesting systems
- Catch basin filters
- Practices that can be implemented on individual parcels or in the parkway to store, infiltrate, and treat runoff from that parcel.

Centralized BMPs refer to stormwater treatment, storage, or infiltration facilities that provide benefits on a larger scale (e.g., regional). Such projects can include neighborhood-scale or larger-scale facilities such as:

- Spreading grounds
- Flood control facilities
- Park space that provides treatment/infiltration of runoff from nearby areas.

The BMPs presented above are all not equally suitable to all site conditions and performance goals across watersheds. Consequently, several important site specific factors were considered when identifying those BMPs to include in the project analysis.

The following sections describe the process used to assess opportunities for implementing structural BMPs; both distributed and centralized. Section 6 describes the evaluation of BMP alternatives using an optimization process.

5.1 Summary of Structural Solutions

A phased approach is necessary for implementing structural solutions. The first priority was given to approaches that do not require obtaining land tenure, which may be projects within publicly owned right-of-ways or programs that encourage private owners to implement structural BMPs within their own properties. The next phase will involve public acquisition of property on which structural solutions can be implemented. The creation of public-private partnerships to implement structural solutions will also be considered. A summary of the pollutant removal mechanisms and capabilities of structural BMPs is provided in Table 5.1.

Table 5.1 Pollutant removal mechanisms and capabilities of structural BMPs

Structural BMP	Pollutant Removal Mechanism	Total Nitrogen	Total Phosphorus	Toxics[1]
Infiltration Basin	Infiltration	H	H	H
Detention Basin	Settling	M	M	M
Constructed Wetland	Biological Uptake, Settling	M	H	H
Catch Basin Inserts	Settling, Filtration	L	M	M
Bioretention	Adsorption, Settling, Biological Uptake, Infiltration	M	H	H
Porous Pavement	Infiltration	M	H	H

Notes:
H: high; M: medium; L: low
Scoring modified from International BMP Database, 2010.
(1) Performance data is not widely available for this pollutant class; assumed that removal efficiency would be similar to sediments since these pollutants are largely associated particulates
(2) Phosphorus index of fill soils in bioretention areas will cause a high total phosphorus outflow; high TP removal efficiency is dependent on the fill soils having a low P-index
(3) Nitrogen removal by bioretention areas can be increased using a design variation that creates an anaerobic zone below the drainpipe.

5.2 Assessment of Opportunities for Distributed Structural BMPs

It was not feasible within the TMDL Implementation Plan to identify and size each distributed structural BMP in the TMDL Implementation Area. Rather, within specific classifications of land characteristics (e.g., impervious roads, land use, soil type), general assumptions were established that provide insight regarding the types and benefits of distributed BMPs that can be implemented at a larger scale. That resulted in identifying key distributed structural BMP projects that could be considered for TMDL implementation planning.

Two major categories of distributed structural BMPs were identified, which were based on site characteristics and the types of BMPs determined feasible: 1) catch basin distributed BMPs and 2) other distributed BMPs on public land. The following provides detailed discussions for these categories and the proposed projects for TMDL implementation.

5.2.1 Catch Basin Distributed BMPs

Storm drain systems in developed areas typically begin with inlets at the street level. Stormwater inlets have a variety of names, and there are regional differences in terminology. In California, storm drain inlets are routinely called catch basins.

As discussed in Section 3, roads represent a major source of TMDL pollutant loads, and therefore treating road runoff is considered a key strategy for multi-pollutant TMDL implementation. Because of the number and spatial distribution of catch basins in the TMDL Implementation Area, they represent an excellent opportunity for treating pollutants in addition to trash.

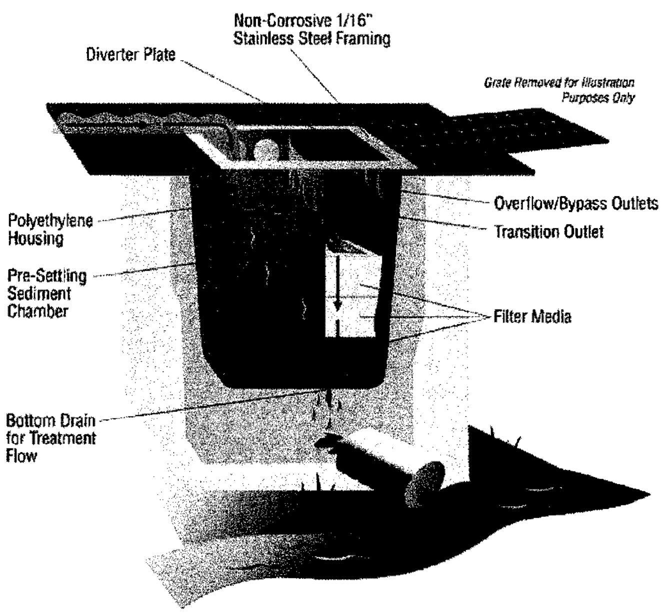


Figure 5.1 Example of Catch Basin Filter Inserts

5.2.1.1 Catch Basin Filter Inserts

Catch basin filter inserts, as illustrated on Figure 5.1, are devices designed specifically to capture trash, oil/grease, other floatables, sediment, organics, and other pollutants—can offer additional pollutant removal benefits. On the basis of a synthesis of available studies, catch basin filter inserts are expected to treat and remove a significant fraction of sediment (and associated metals and toxics) with treatment focused on runoff from the transportation network. The treatment efficiency of catch basin filter inserts for bacteria is poorly studied and unknown but is likely to be very low unless the insert has a design element targeting bacteria. Such devices tend to have a 1- to 3-year warranty and would need maintenance or replacement after that. Catch basin inserts can replace full capture devices upon installation depending on whether the space they occupy is compatible with the full capture device. Some devices (such as the Abtech Smart Sponge™) can be installed in tandem with existing full capture devices.

Implementing catch basin filter inserts throughout the TMDL Implementation Area is highly applicable because of the high density of catch basins. The TMDL Implementation Area includes almost 811 catch basins, which equates to approximately 1 catch basin every 200-300 lineal feet of stormdrain. The distribution of catchbasins within the TMDL implementation area is summarized in Table 5.2.

Table 5.2 Summary of Catch Basins by Subwatershed

Subwatershed	Storm Drain Length (mi)	Number of Catch Basins	Catch Basin Density (CB/mi)
Walteria Lake	25	373	15
Airport	14	173	12
Walnut Sump	9	242	27
Baseball Field	1.4	23	17
Total	**50**	**811**	**16**

Notes:
(1) Based on count from City's storm drainage atlas maps

The City is currently in the process of installation of full capture devices for compliance with the trash TMDL. Implementing catch basin filter inserts would require retrofitting or replacing the full capture devices that have been installed. For the TMDL Implementation Plan, implementing catch basin inserts is assumed to focus on replacing existing full capture devices with catch basin filter inserts, which is a more resource intensive, conservative approach. During actual implementation, other more cost-effective approaches for full capture device retrofit could be employed. The schedule for implementing catch basin inserts in the TMDL Implementation Area considers maximizing the operational period of installed full capture devices, thus improving the return on the investment. Implementing catch basin inserts would involve internal planning, conducting a pilot study to gain approval from the LARWQCB for attaining the trash TMDL requirements (for cases where full capture devices are being retrofitted or replaced), installing the devices, and maintaining the sediment-removal insert as part of the existing catch basin maintenance activities.

5.2.1.2 Other Distributed BMPs on Public Land

Before stormwater enters the storm drain systems, opportunities are available for the storage, infiltration, and treatment of runoff within publicly owned right-of-ways or parcels. Such areas include road right-of-ways or other properties owned by public agencies for various purposes (e.g., parks, schools, storage, and utilities). Figure 5.2 shows the publicly owned parcels within the TMDL Implementation Area. In combination with road right-of-ways, this area represents a significant opportunity for on-site stormwater treatment.

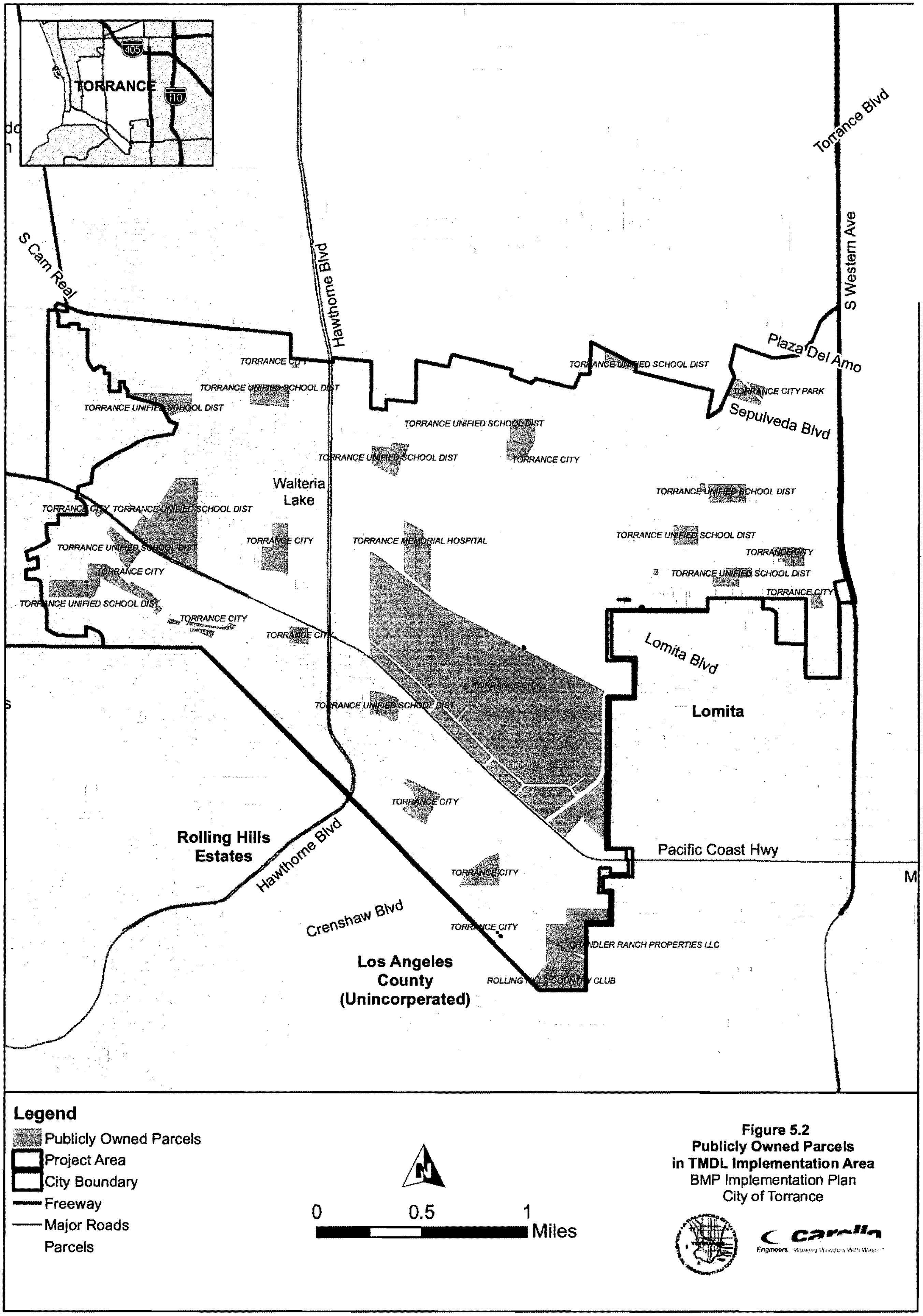


Figure 5.2
Publicly Owned Parcels
in TMDL Implementation Area
BMP Implementation Plan
City of Torrance

5.2.2 Low Impact Development

The County of Los Angeles adopted a low impact development (LID) ordinance on January 1, 2009, which directly influences the selection and use of structural BMPs. New development and future redevelopment within the City are subject to LID requirements. The requirements are intended to result in runoff quantities and quality that mimic the runoff from undeveloped areas, up to and including runoff from a 50-year design storm event.

Development projects with four or fewer residential units are required to implement two LID BMP alternatives as specified in the County LID Standards Manual. LID BMP alternatives include, but are not limited to the following measures:

- Disconnecting impervious areas
- Installing porous pavement
- Dry wells
- Conforming to landscaping and irrigation requirements
- Installing green roofs

Developments with five or more units or nonresidential developments are required to provide infiltration for excess runoff volume. Runoff from these developments that mimics the natural hydrograph must meet treatment requirements. Redevelopment projects where at least 50 percent of the impervious surfaces are altered must mitigate the entire project area. Redevelopment projects that alter less than 50 percent of the impervious area only need to mitigate the alteration.

Implementation of LID BMPs within the TMDL Implementation Area provides an opportunity to reduce the loading of pollutants by reducing concentrations of pollutants in runoff and reducing the volume of runoff.

Both development and redevelopment are largely driven by the strength of the economy. Currently, the rate of development is near a historic low and as a result, estimates for gains from LID and the schedule for those gains are difficult to quantify. As part of the adaptive management implementation, the effects of implementing LID BMPs through development and redevelopment will be tracked though the monitoring and reporting program. Increased levels of development or redevelopment should result in decreases in pollutant loading from the TMDL Implementation Area, reducing the need for additional structural controls. Stagnation of development in the TMDL Implementation Area may lead to an extended schedule or require additional structural controls to attain TMDL WLA levels.

5.3 Assessment of Opportunities for Centralized Structural BMPs

To identify, evaluate, and ultimately select the optimal combination of centralized structural BMPs to address pollutant load reductions for the TMDL Implementation Area, key information was required. Investigations were performed to identify and assess potential sites for placing centralized structural BMPs on public land. Priority locations of centralized structural BMPs were publicly owned properties to reduce the need for land acquisition. Additional consideration was made regarding the necessity for implementing centralized structural BMPs on private land. Results of this assessment provided information necessary to support TMDL implementation planning.

5.3.1 Site-Screening Methodology

An initial analysis was conducted to identify all publicly owned parcels in the TMDL Implementation Area. That initial screening resulted in approximately 24 parcel groups as shown on Figure 5.2. The 24 parcel groups included any publicly owned land with no analysis of the suitability for a centralized BMP. Most of the sites provide adequate space for a centralized BMP. They are not too steep, or are within a feasible distance of a stormwater drainage system.

Additional screening was performed to further narrow potential sites for additional investigation. Additional field investigations were performed for identified locations to assess site and drainage area characteristics and identify the ideal BMP that could be constructed at the site.

Subsequently, GIS analysis was performed of land ownership parcels and site characteristics to identify potential sites for centralized BMP placement on publicly owned parcels. Considerations in the analysis included the following:

- **Land cost**—Land costs were minimized by identifying publicly owned parcels.
- **Percent impervious**—Areas with higher percent imperviousness would produce more runoff during typical rain events. Higher impervious areas were targeted for greater potential volume reduction and water quality improvements.
- **Space requirements**—Sites were evaluated to determine if space is available to implement an appropriately sized BMP.
- **Watershed treatment area**—The size of the TMDL Implementation Area drainage area for each site was evaluated on the basis of available storm drain or Digital Elevation Model (DEM) data. Sites were identified that provide sufficient space for BMPs to adequately treat/store/infiltrate runoff from their respective drainage areas.

- **Soil type**—Soil type was evaluated as an initial estimate of the infiltration rate and capacity of the soils. Sites with infiltration rates suitable for infiltration BMPs were further investigated.

- **Slope**—Slopes of sites were considered on the basis of DEM or other available topography data sets. Sites with moderate slopes (less than 10 percent for GIS purposes) were considered for centralized BMPs. Slope was verified in the field investigation, and sites where the slope is inappropriate for a centralized BMP were eliminated.

- **Multi-benefit use**—Sites were identified that could serve multiple purposes. For instance, some stormwater practices, such as infiltration basins or grassed swales, could serve a dual purpose of stormwater management and community park space. Several parks could be altered to provided stormwater treatment and storage.

Those criteria were evaluated to identify sites where centralized BMPs would be feasible. Sites that could provide enough space to effectively treat the drainage area associated with the site, that have soils suitable for infiltration, and that are publicly owned (to reduce land acquisition costs) were preferred. Sites that could provide a multi-benefit use, such as parks or parking lots where belowground storage could be used, were considered ideal. From the GIS screening analysis, a list of potential locations for centralized BMPs was developed to address stormwater runoff from the TMDL Implementation Area.

This GIS screening and additional field investigations narrowed the potential sites to the following five sites (which are also depicted on Figure 5.3):

- Airport 1 – A1
- Airport 2 – A2
- Airport 3 - A3
- Walnut Sump
- Baseball Field

Details regarding the proposed structural BMP improvements are presented in subsequent subsections, while general observations and strategies used to develop these BMP concepts are described below.

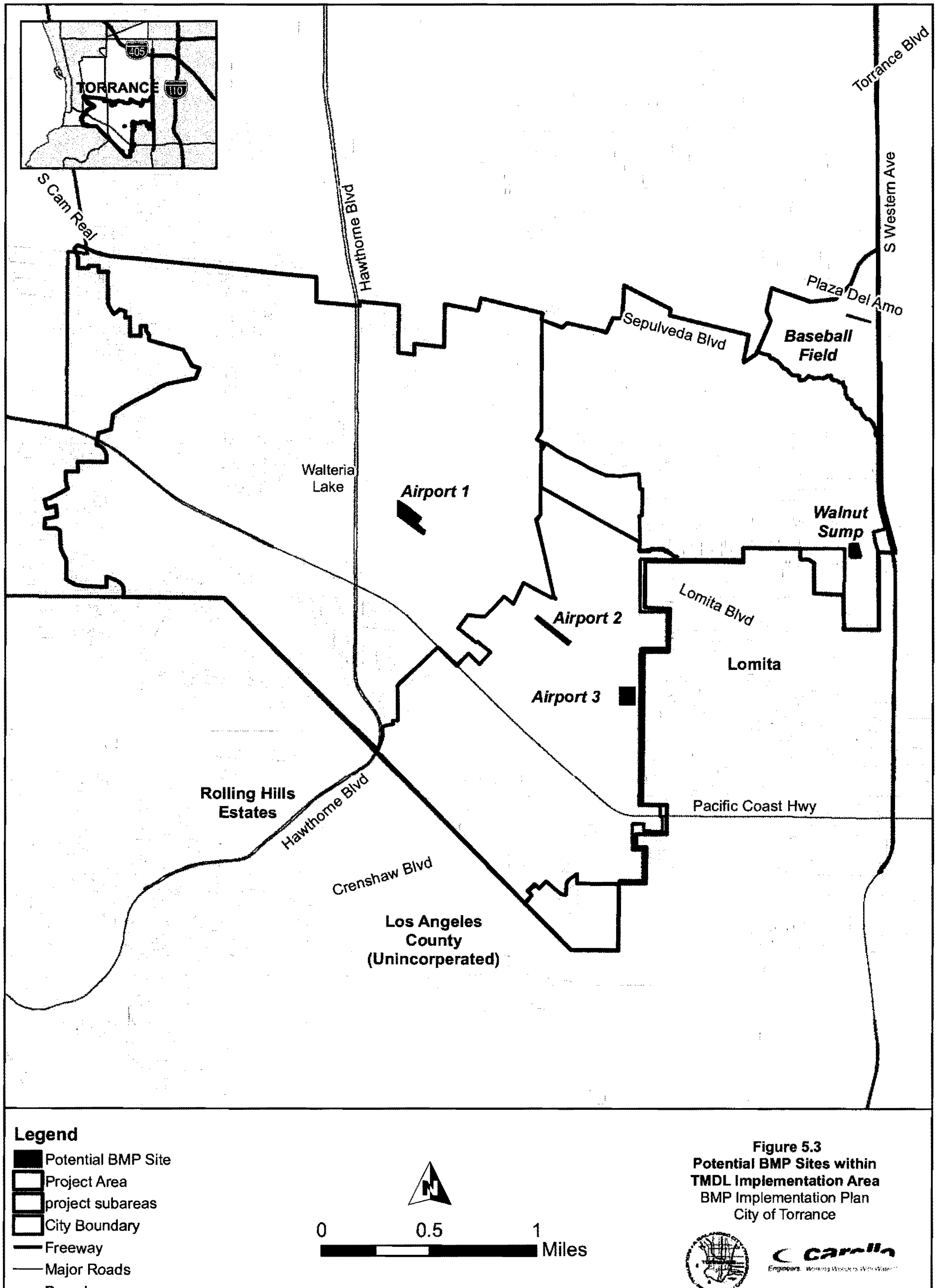


Figure 5.3
Potential BMP Sites within TMDL Implementation Area
BMP Implementation Plan
City of Torrance

Because existing site layouts and features can have an effect on where and what type of BMPs can be installed on a site, site layouts and on-site structures were photographed and documented to support evaluation of the site for centralized BMPs. The considerations included the following:

- **Effects on surrounding areas**—Any nearby structures, including storm drains and utilities, were documented. Any effects that could occur to surrounding structures because of settlement issues were noted.
- **Maintenance/accessibility**—Every BMP must be maintained at some level for the BMP to continue to function as it was designed. BMPs were considered that maximize access for maintenance purposes.
- **Research potential**—Research of stormwater BMPs is ongoing and necessary to fill existing data gaps and to continue to support the City in developing BMP standards. Monitoring protocol would be considered and incorporated into the design of each BMP that is implemented.

The individual site characteristics and summary of field investigations and BMP recommendations are described below. The description includes results of field tests to evaluate infiltration rate, water table depth and soil quality; more detailed maps of potential BMP sites; and photographs of the watershed treatment area and available BMP area for each site. Centralized structural BMP options for the sites were narrowed down to specific BMP types and sizes during the process of evaluating nonstructural and structural solutions.

The watershed treatment areas for each of the five identified sites, unless otherwise noted, are residential with concentrated or dispersed density configurations. Residential areas are known to generate high levels of nutrients, such as nitrogen and phosphorus, typically from over fertilization and excess irrigation. Detergents used to wash cars in residential areas can contain high levels of phosphorus. Residential areas are also a source for metals and bacteria. While the largest portion of the watershed treatment areas are residential, there are also institutional and commercial areas in many of the watersheds. Institutional and commercial areas are typically a source of metals, nutrients, and PAHs. Additional pollutant source discussion is included in each site discussion where additional detail is required.

On the basis of observed conditions at all the potential BMP sites, two types of centralized BMPs could be implemented in the open space at the five sites: underground storage/infiltration basins and extended dry detention/infiltration basin. Three of the potential BMP sites, A1, A2 and A3 are located at the Torrance Airport, one at Walnut Sump and the last site is located under the road near Torrance Baseball Field. The sites were also selected to eliminate or minimize the need for pump stations. Each centralized BMP is suitable for treating nutrients, toxics, metals, and other pollutants typically delivered with suspended sediment (e.g., organic pesticides, PAHs) in stormwater. Infiltration basins require high infiltration rates and are not designed to store water for extended periods. Underground storage/infiltration systems are suitable in areas with hydrologic soil group (HSG) C soils and soils in the lower range of HSG B where infiltration is possible but could take longer.

The five potential sites investigated do not have hard surface areas such as tennis courts, basketball courts, playgrounds, skateboard parks, and parking areas. These potential sites do not require a structural foundation and therefore could be used for belowground storage and treatment. Storm chambers installed below these surfaces would provide additional treatment while still allowing the areas to be used for recreation and parking.

The type and size of the BMP were determined through further optimization analysis and reported in Section 6. The BMPs are planned to infiltrate water within a few days, reducing possible public health risks from stagnant water such as mosquitoes and drowning. An infiltration basin could still be used for recreation and open space activities between storm events and during the dry season. Belowground BMPs could have overlying space available for recreation or parking regardless of the weather.

Each of the investigated potential centralized BMP sites has ample open space to provide access for maintenance. Observed maintenance at each potential site includes regular mowing similar to the required maintenance for an aboveground-centralized BMP. To maintain infiltration functionality, sediment would need to be removed when infiltration rates are reduced twenty-five to fifty percent from the design infiltration rate. Infiltration rates can be restored by removing accumulated sediment and disking or aerating the surface. Sediment from belowground BMPs would have to be removed annually or as needed.

Considering current usage, ample space would be available for construction activities at each investigated site. While the focus of each of the potential centralized BMPs is TMDL compliance, implementing such BMPs also aligns with several integrated water resources planning objectives. In addition to the intended BMP objective of water quality improvement, a centralized BMP at each of the proposed sites would contribute to flood protection, water conservation, groundwater replenishment, and improved aesthetics.

5.3.2 Utility Search

Prior to recommending a potential BMP site, a utility search was conducted. Known utilities companies contacted for utility information regarding the project area include:

- Sempra – Gas utility
- Southern California Edison – Electric utility
- Metropolitan Water District of Southern California (MWDSC)

Utility information obtained from the companies were included in the database created for this project. Analysis of the utility information indicates that there appears to no potential conflict with the proposed projects. The utility information is included in Appendix D.

5.3.3 Geotechnical Investigation

Accurately identifying the Hydrologic Soil Group (HSG) of the existing soils is also an important first design step in computing BMP design treatment volume and appropriate runoff reduction credit. The initial screening of the on-site soils was conducted to identify basic soil characteristics related to stormwater management, such as the HSG and other features relevant to construction activities (e.g., erosion and sediment control). Also, through the initial screening areas where more detailed soil investigation and field determinations may be needed to refine the limits of the different HSGs as defined in the soil survey were identified. The initial screening also included the identification of locations deemed suitable for infiltration BMPs and therefore further detailed geotechnical investigations.

Due to concern regarding infiltration rates at the Torrance Airport, a geotechnical investigation of this site was conducted using three soil borings. Details of this subsurface investigations are summarized in Appendix E. In summary, it can be concluded that the boring logs indicate that the top layer below surface at the Airport consists of a thin layer of silty sand followed by sandy clay, alluvium, and clay deposits. At depths ranging from 25 to 45 feet below surface, a sand layer is present. This layer would be most suitable for infiltration of stormwater. Hence, substantial excavation would be required to install the underground infiltration galleries at this site, which results in higher cost and difficult access for maintenance. More details regarding this BMP site is provided in the next section.

5.3.4 Torrance Airport Basin

The Torrance Airport Basin is about 60 percent impervious with a concentrated impervious configuration and moderate road density. There are three proposed BMP sites all located at Torrance Airport (A1, A2, and A3). These are open areas and are well maintained, suggesting the use of fertilizers that have high levels of nutrients and some metals, such as copper, adding another source of nutrients and metals to the stormwater runoff from the area.

For the purposes of BMP implementation in this area, the drainage basin is subdivided into four treatment subcatchments, AS1, AS2, AS3, and Walteria Lake, shown on Figure 5.4. Stormwater runoff from these four subcatchments could be diverted to the three potential sites; A1, A2 and A3 for treatment. The subcatchments were delineated based on drainage characteristics and storm drain layout. Stormwater runoff from AS3 could be treated at A3, AS2 stormwater would be diverted to A2 and Walteria Lake discharge diverted to A1 for treatment.

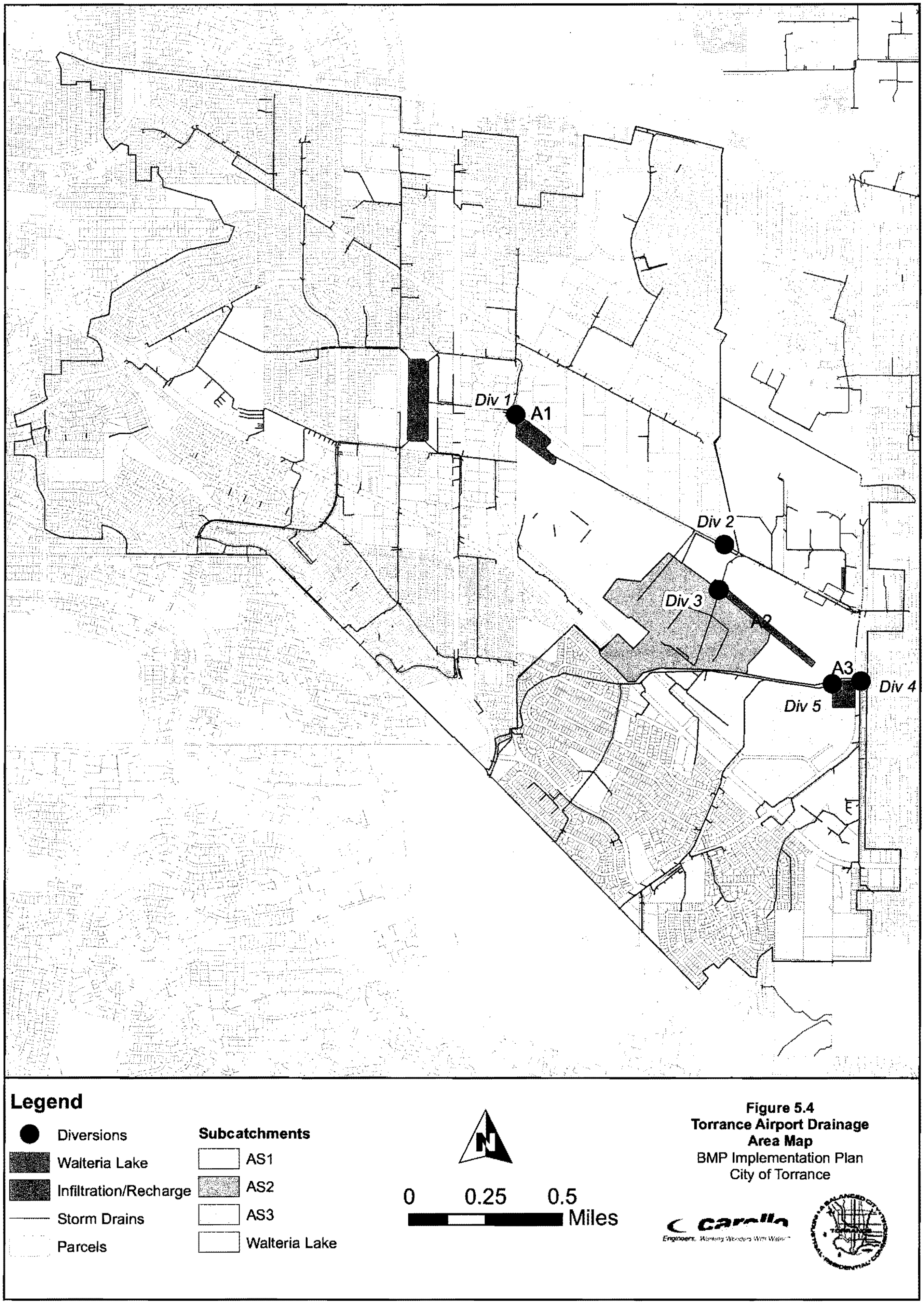


Figure 5.4
Torrance Airport Drainage Area Map
BMP Implementation Plan
City of Torrance

Based on the storm drain layout, it is not costeffective to divert stormwater from AS1 to any of the three BMP sites. Therefore, non-structural BMPs will be considered for this subcatchment.

The Walteria Lake subcatchment is served by Walteria Lake, which acts as an extended wet detention basin. Stormwater is pumped from the lake through a 54-inch diameter force main. During big storms and/or pumping conditions, there is a high potential for sediment resuspension. This may lead to high pollutant discharge into Machado Lake. To prevent pollutant discharge into Machado Lake and thereby meet WLAs, discharge from Walteria Lake could be diverted at two locations into potential BMP sites A1 and A2 as shown on Figure 5.5. However, A1 and A2 are designed based on Torrance watershed only. Additional capacity to treat flow volume pumped from Walteria Lake is not part of this report. A1 could be expanded with financial participation from the LA County Flood Control District (LCFCD).

5.3.4.1 Subcatchment Volume Associated with 85th Percentile, 24 Hour Storm

Wherever feasible, the City wants to capture and retain all non-stormwater runoff and all stormwater runoff from the 85th percentile, 24 hour storm event for the drainage area tributary to the BMP site. The applicability of the three BMP sites to capture and treat the 85th percentile runoff volume for each subcatchment was investigated. The total surface area and volume requirements for each potential BMP site is summarized in Table 5.3. As shown in the table, the potential BMP sites A1, A2 and A3 have adequate surface area to implement underground storage/infiltration system to treat stormwater generated from their respective subcatchments. The total depth of the proposed underground storage/infiltration system would range between 4 and 8 feet.

Table 5.3 Summary of BMP Requirements –Torrance Airport

BMP Site	Drainage Area Treated (ac)	Percent Imperviousness	Treatability[1]	Water Quality Volume (ac-ft)	Water Quality Flow (cfs)	BMP Capacity (ac-ft)
A1	NA[2]	NA	NA	NA	57	22.4
A2	86	45	6.7%	1.5	10.8	12.0
A3	640	59	66.1%	28.3	97.6	32.8

Notes:
(1) Treatability: Fraction of impervious surface in subcatchment treated by BMP
(2) Only effluent discharged from Walteria Lake subcatchment.

Figure 5.5
Conceptual Layout of Torrance Airport Underground Storage/Infiltration BMP
Stormwater Recharge Project
City of Torrance

The three sites were also evaluated to determine if the soils at the sites meet infiltration requirements. Based on geotechnical evaluation, BMP site A3 is the least feasible site to implement underground storage/infiltration due to the presence of a thick clay layer. Infiltration system at the site will have to very deep and will be costly. Therefore, underground storage/infiltration system would be implemented at site A3 only when additional treatment is required after installation of BMPs at sites A1 and A2. Sites A1 and A2 have enough capacity to capture and infiltrate the 85th percentile runoff from subcatchments AS2 and AS3. The total capacity of sites A1 and A2 is approximately 34.4 ac-ft. Therefore, AS2 and AS3 can be designated as 85th Percentile Basins.

5.3.4.2 Torrance Airport Basin Treatment Scenarios

Table 5.4 shows a summary of the pollutant load generated from subcatchments AS1, AS2 and AS3. These three subcatchments represent approximately 23 percent of the Implemetation Area. However, they generate about 95 percent of the total phosphorus load generated from the entire Implementation Area. Therefore, for the City to meet the TMDL requirements, stormwater generated from these subcatchments must be managed using watershed-based strategies that combine structural and institutional or non-structural BMPs.

Table 5.4 Torrance Airport Subcatchment Pollutant Load Summary

	Pollutant Load (kg/yr)			
Subcatchment	**TSS**	**TP**	**TN**	**Toxics**
AS1	19,627	168	1,131	1.50
AS2	4,694	41	273	0.36
AS3	47,984	411	2,765	3.66

<u>Subcatchment AS1</u>

Stormwater generated from subcatchment AS1 will be treated soley with non structural BMPs. Non-structural BMPs recommended for implementation in AS1 include:

- Street sweeping – toxics and other pollutants released to the urban environment during dry weather conditions are likely to adsorb on street sediments, which provide mechanism for metals to reach downstream waterbodies. Street sweeping removes sediment, debris, and other pollutants from road and parking lots surfaces. Street sweeping is also proposed in subcatchments AS2 and AS3.

- Catch Basin Filter Inserts/Cleanouts – continuation of catch basin cleaning programs will contribute to removal of sediments prior to entering the storm drains. The pollutant removal mechanisms of catch basin inserts are: screening, sedimentation, flotation, and absorption. Debris and large particles are removed by screening; smaller particles and sediment along with associated hydrocarbons, metals, nutrients, toxics and pathogens are removed by settling; and hydrocarbons that are not associated with sediment are removed by absorption.

This Implementation Plan through modeling which is discussed in Section 6 proposes combined efficiencies of non-structural BMPs 30% for sediment, 10% for phosphorus and 23% for nitrogen. Toxics removal is assumed to be directly related to sediment removal efficiency. The assumptions underlying the modeling efforts are discussed in Section 6.

Subcatchment AS1 has a total drainage area of about 249 acres with average imperviousness of about 60 percent. Stormwater runoff from AS1 will be captured by a total of 57 catch basin filter inserts. All the 57 catch basins will be retrofitted to allow the installation of full capture filters. Table 5.5 presents the expected outcome after implementation of non-structural BMPs in subcatchment AS1.

Table 5.5 Torrance Airport Basin - Summary of Load Reduction from Quantified BMPs for Subcatchment AS1

	Load (lb/yr)			
BMP Scenario	**TSS**	**TP**	**TN**	**Toxics**
Before BMP	19,627	167.8	1,131	1.50
After BMP[1] (Load reduction)	13,739	151	871	1.05
% Load Reduction	30	10	23	30

Note:
(1) Load reduction by combined non-structural BMPs

Subcatchments AS2 and AS3

Both non structural and structural BMPs are recommended for subcatchements AS2 and AS3. Street sweeping and storage/infiltration system will be implemented in these two subcatchments. The storage/infiltration system will be implemented in phases at BMP sites A1 and A2. In phase 1 an 8 feet deep underground storage/infiltration system will be implemented at Site A2. The implementation of underground storage/infiltration system in Phase 2 will depend on the effectiveness of the Phase 1 BMP. The Implementation Plan calls for an integrated, adaptive management approach to utilize available resources effectively and efficiently. If through continued study of drainage patterns, diagnosis of problem sources, and new technologies for dry and wet weather treatment, it is realized that more treatment is needed in the Airport treatment area, BMP site A1 will be considered for implementation of additional storage/infiltration system in Phase 2.

In Phase 1, runoff generated from subcatchments AS2 and AS3 will be treated at Site A2. Under this phase, two options have been identified and illustrated on Figures 5.6A and 5.6B. In Option 1, stormwater runoff will be diverted from Crenshaw Blvd and Amsler Street, and pump through a 14-inch forcemain to another diversion system at Crenshaw Blvd and 250th Street. From here, the stormwater will flow by gravity to the infiltration system at Site A2. To improve infiltration in this area, the infiltration system should be located at a depth not less than 40 feet from the ground surface.

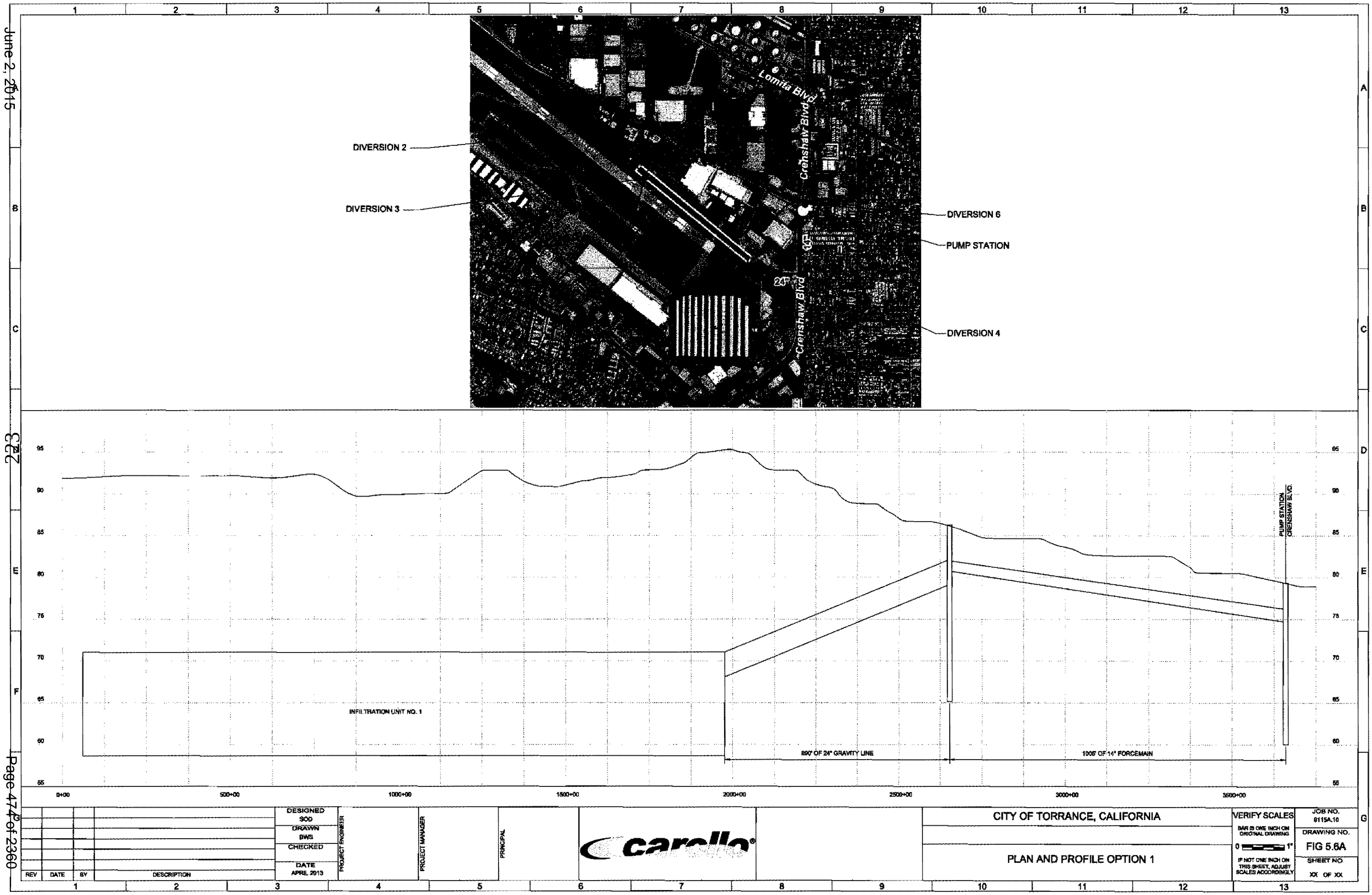
Option 2, which is the preferred option, stormwater diverted from storm drains at Crenshaw Blvd. and Amsler St. and Crenshaw and 250th Street will flow by gravity into the infiltration system at Site A2. Stormwater from Crenshaw Blvd. and Amsler Street will be conveyed through a 21-inch diameter to Crenshaw and 250th Street. From here, the stormwater will be conveyed through a 24-inch diameter pipe to the infiltration system for treatment. Table 5.6 presents the the expected outcome after implementation of non-structural and structural BMPs to treat stromwater runoff from subcatchments AS2 and AS3.

Table 5.6 Torrance Airport Basin - Summary of Load Reduction from Quantified BMPs for Subcatchments AS2 and AS3.

	Load (lb/yr)			
BMP Scenario	**TSS**	**TP**	**TN**	**Toxics**
Before BMP	52,677.8	451.3	3,037.5	4.02
After BMP[1] (Load reduction)	48,779.6	321.3	2,308.5	3.72
% Load Reduction	92.6	71.2	76.0	92.6

Note:
(1) Load reduction by combined non-structural and structural BMPs

The storage requirements summarized in Table 5.3 were incorporated into the water quality model to simulate the effectiveness of the BMPs. All assumptions used in the pre-BMP model scenario were retained. The simulations do not include non-structural BMPs such as street sweeping and catch basin inserts. The nonstructural BMPs were evaluated separately.


DIVERSION 2
DIVERSION 3
DIVERSION 6
PUMP STATION
DIVERSION 4
Lomita Blvd
Crenshaw Blvd
24"
INFILTRATION UNIT NO. 1
890' OF 24" GRAVITY LINE
1005' OF 14" FORCEMAIN
PUMP STATION
CRENSHAW BLVD.
0+00
500+00
1000+00
1500+00
2000+00
2500+00
3000+00
3500+00
CITY OF TORRANCE, CALIFORNIA
PLAN AND PROFILE OPTION 1
VERIFY SCALES
JOB NO.
9115A.10
DRAWING NO.
FIG 5.6A
SHEET NO
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DESIGNED
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PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL
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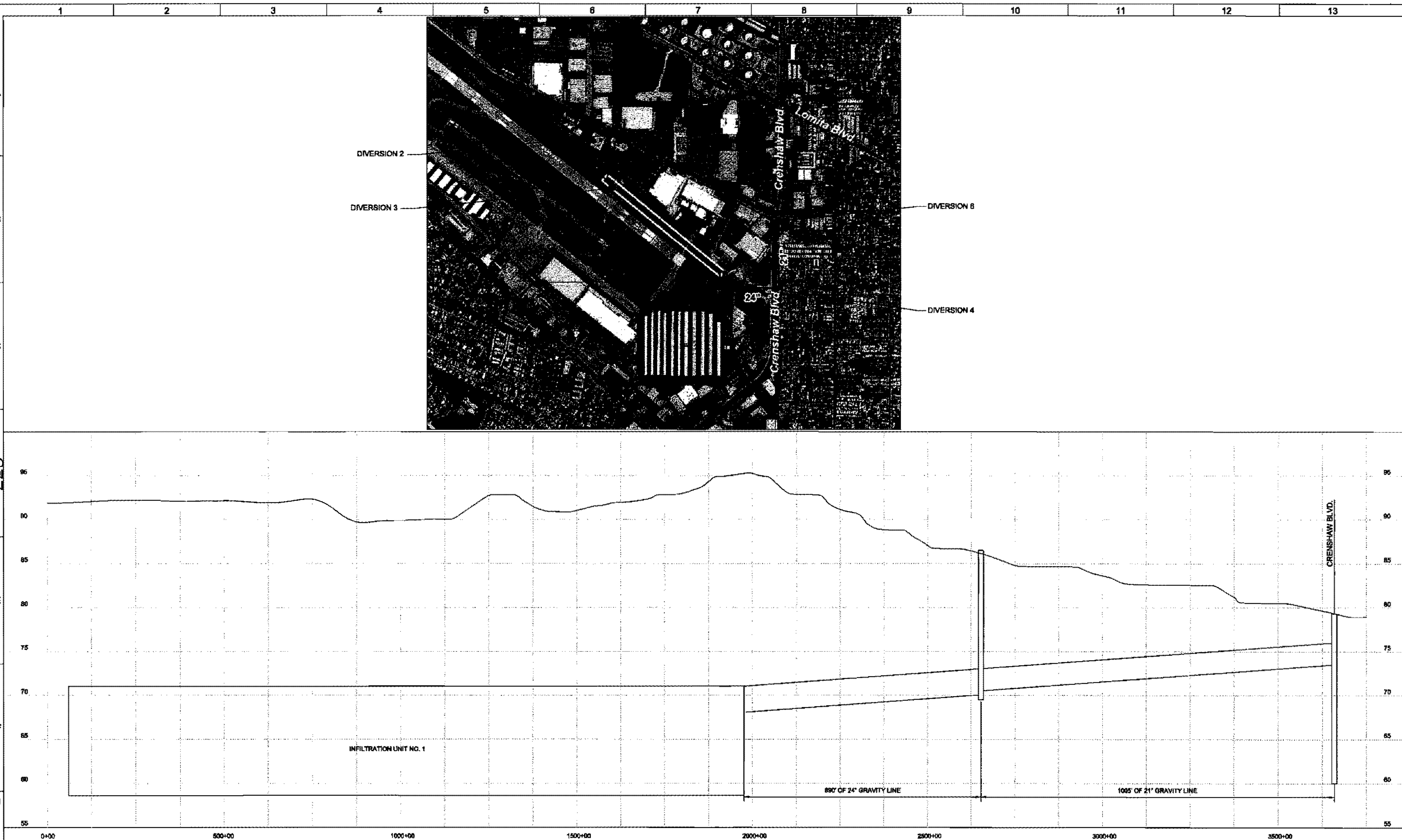

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DESIGNED BOD
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DATE APRIL 2013

PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

Carollo®

CITY OF TORRANCE, CALIFORNIA

PLAN AND PROFILE OPTION 2

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 9116A.10
DRAWING NO. FIG 5.6B
SHEET NO. XX OF XX

5.3.4.3 Recommended BMP Implementation in Torrance Airport Basin

The Torrance Airport subcatchments, AS1, AS2 and AS3 represent approximately 23 percent of the Implemetation Area. However, they generate about 95 percent of the total phosphorus and 44 percent of sediment load generated from the entire Implementation Area. The City has to implement BMPs to treat stormwater generated in this area in order to comply with the established TMDLs in the Machado Lake Watershed.

In addition to street sweeping, catch basin filter inserts and other non-structural BMPs discussed earlier, two potential sites, A1 and A2 are recommended for implementation of underground storage/infiltration system as part of Option 2 shown on Figure 5.7. The sites were selected based on space availability, soil conditions, and cost effectiveness. These non-structural and structural BMPs can be implemented in three phases.

In Phase 1, an eight feet deep underground storage/infiltration system will be installed at Site A2 to receive stormwater runoff through 21- and 24-inch diameter gravity pipes. Since this Plan calls for an adaptive management approach to utilize available resources effectively and efficiently, if through continued study of drainage patterns, diagnosis of problem sources, and new technologies for dry and wet weather treatment, it is realized that more treatment is needed in the Airport treatment area, BMP site A1 will be considered for implementation of additional storage/infiltration system in Phase 2. Phase 3 will consist of installing 57 catch basin inserts in subcatchment AS1.

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP at Torrance Airport would provide additional water supply resources benefits. A centralized BMP at Torrance Airport would be designed to increase infiltration providing additional groundwater replenishment to the groundwater basin. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation.

5.3.5 <u>Walnut Sump Basin</u>

The watershed treatment area that could be treated by the Walnut Sump is about 62 percent impervious with a concentrated impervious configuration and moderate road density. For treatment purposes, this area is divided into three subcatments, WS-1 and WS-2 and WS-3 as shown on Figure 5.8. WS-3 includes drains into SD 1040 shown on Figure 5.8. Two treatment options have been identified for this treatment area. Both options include street sweeping. Option No. 1 will use the existing Walnut Sump to treat about 100 percent of the stormwater generated from subcatchments WS-2 and WS-3 shown on Figure 5.8. If more treatment is needed in this area in order to achieve TMDL compliance Option No.1 could be expanded to include 50 catch basin inserts in WS-1. The catch basins will be retrofitted to allow the installation of full capture filter to capture fine sediments and other pollutants. Walnut Sump, which will receive stormwater from this treatment basin, has adequate capacity to store and infiltrate the 85th percentile 24-hour runoff as shown in Table 5.6.


Div 1
36"
Lomita Blvd.
54"
Div 2
54"
Crenshaw Blvd.
Div 3
Div 6
36"
21"
24"
Div 4
48"
Legend
Diversions
New Conveyance - Gravity Lines
Infiltration/Recharge
Storm Drains
0
1,000
2,000
Feet
Figure 5.7
Recommended BMP
at Torrance Airport
Stormwater Recharge Project
City of Torrance

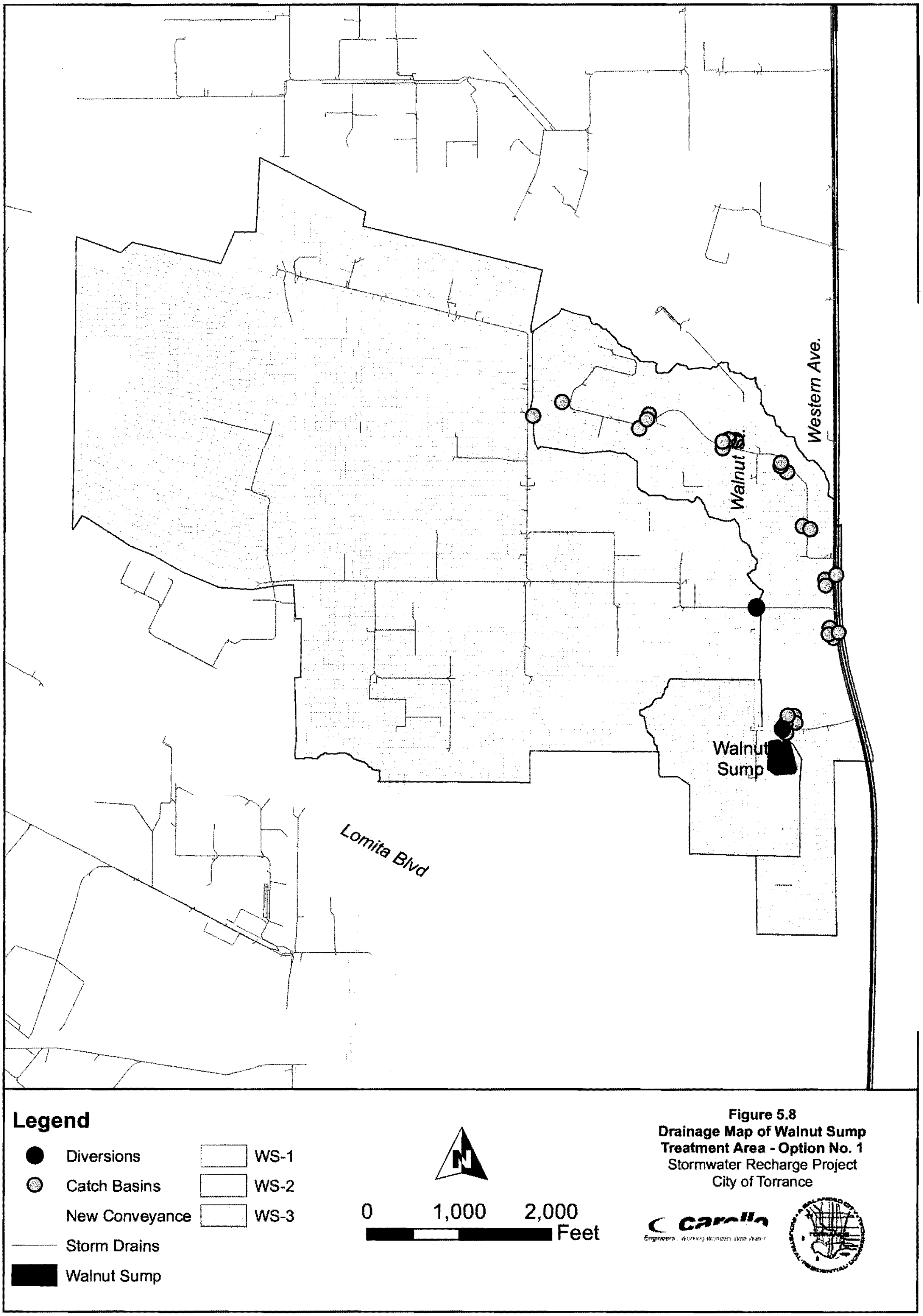


Figure 5.8
Drainage Map of Walnut Sump
Treatment Area - Option No. 1
Stormwater Recharge Project
City of Torrance

In Option No. 1, stormwater runoff from subarea WS-3 will be diverted to Walnut Sump in Phase 1. Phase 2 will consist of installing 50 catch basin filters in WS-1. In Phase 3, stormwater from WS-2 will be diverted from the existing 9.2' x 11' RCB" storm drainpipe at 235th St. and Walnut St. through a new 60-inch diameter gravity pipe to a stormwater lift station to be located at Sur La Brea Park at Walnut Street. From the lift station, stormwater will be pumped through a 24-inch diameter forcemain to Walnut Sump pre-treatment area for further removal of heavy sediments, oil, grease, and floatable wastes. Hydrodynamic Separator unit will be used for the pre-treatment. The pretreated stormwater runoff will then be conveyed to the Walnut Sump main storage area for storage and infiltration

Option No. 2 consists of catch basin inserts only in WS-1 and WS-2 to capture fine sediments and other pollutants as shown on Figure 5.9. Under this option, stormwater from WS-1, WS-2 and WS-3 will be treated by a total of 150 catch basins retrofitted to allow the installation of full capture screens.

Figure 5.10 shows the conceptual layout of both options, while Figure 5.11 and Figure 5.12 show design concept details of both options. Figure 5.13 shows the details of the proposed Walnut Sump storage/infiltration system. Table 5.6 summarizes the storage requirements for this treatment basin.

Table 5.6 Summary of BMP Requirements – Walnut Sump

Option	Drainage Area Treated (ac)	Percent Imper-viousness	Treat-ability	Water Quality Volume (ac-ft)	Water Quality Flow (cfs)	Walnut Sump Capacity (ac-ft)	No. of Catch Basin Inserts
Option No. 1	742	61	79%	39.5	111	50	50-
Option No. 2	922	62	100%	-	-	-	150

The storage requirements summarized in Table 5.6 were incorporated into the water quality model P8 to simulate the effectiveness of the BMPs. All assumptions used in the pre-BMP model scenario were retained. The simulations do not include non-structural BMPs such as street sweeping and catch basin inserts. The results of the simulation runs are summarized in Table 5.7.

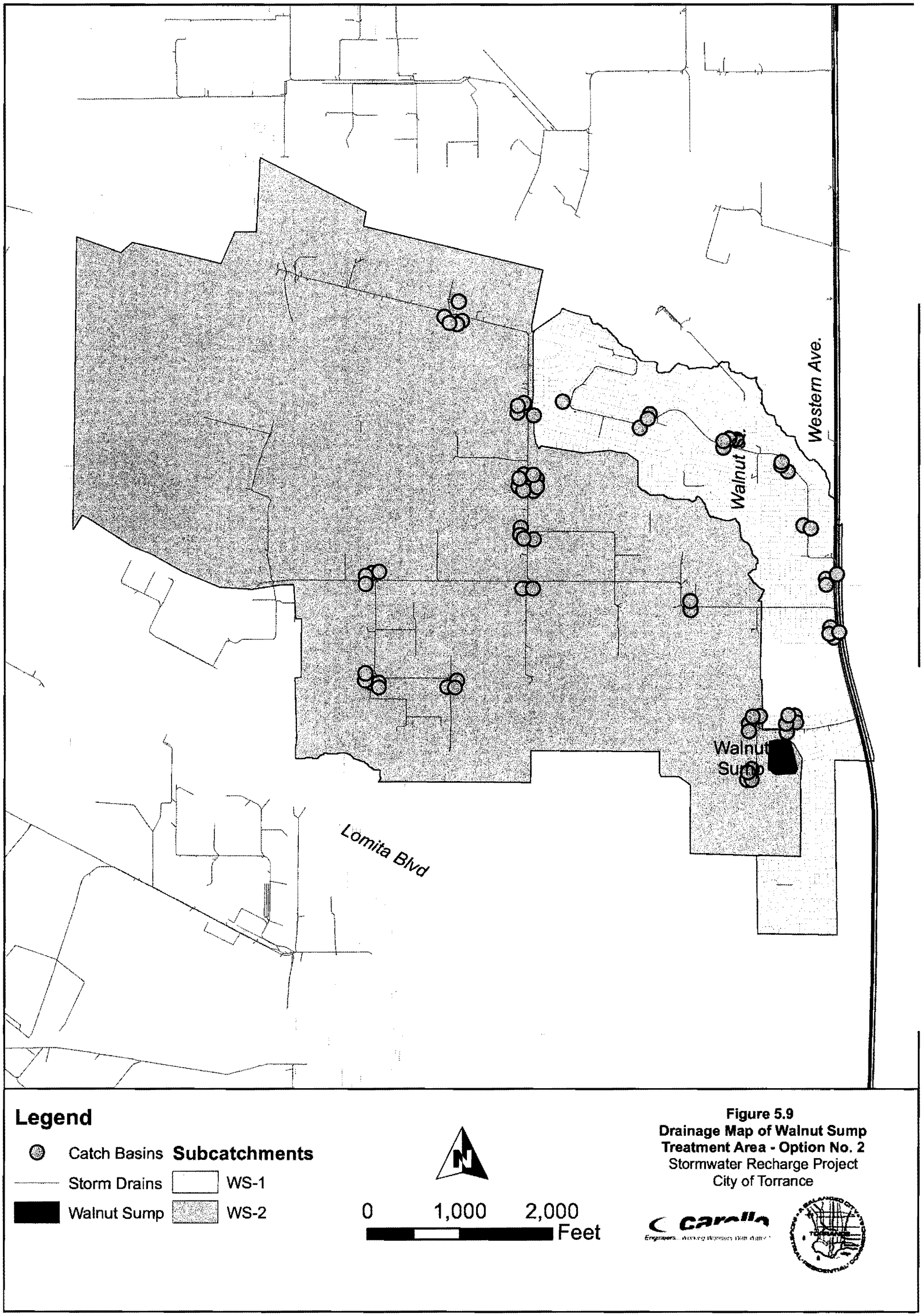


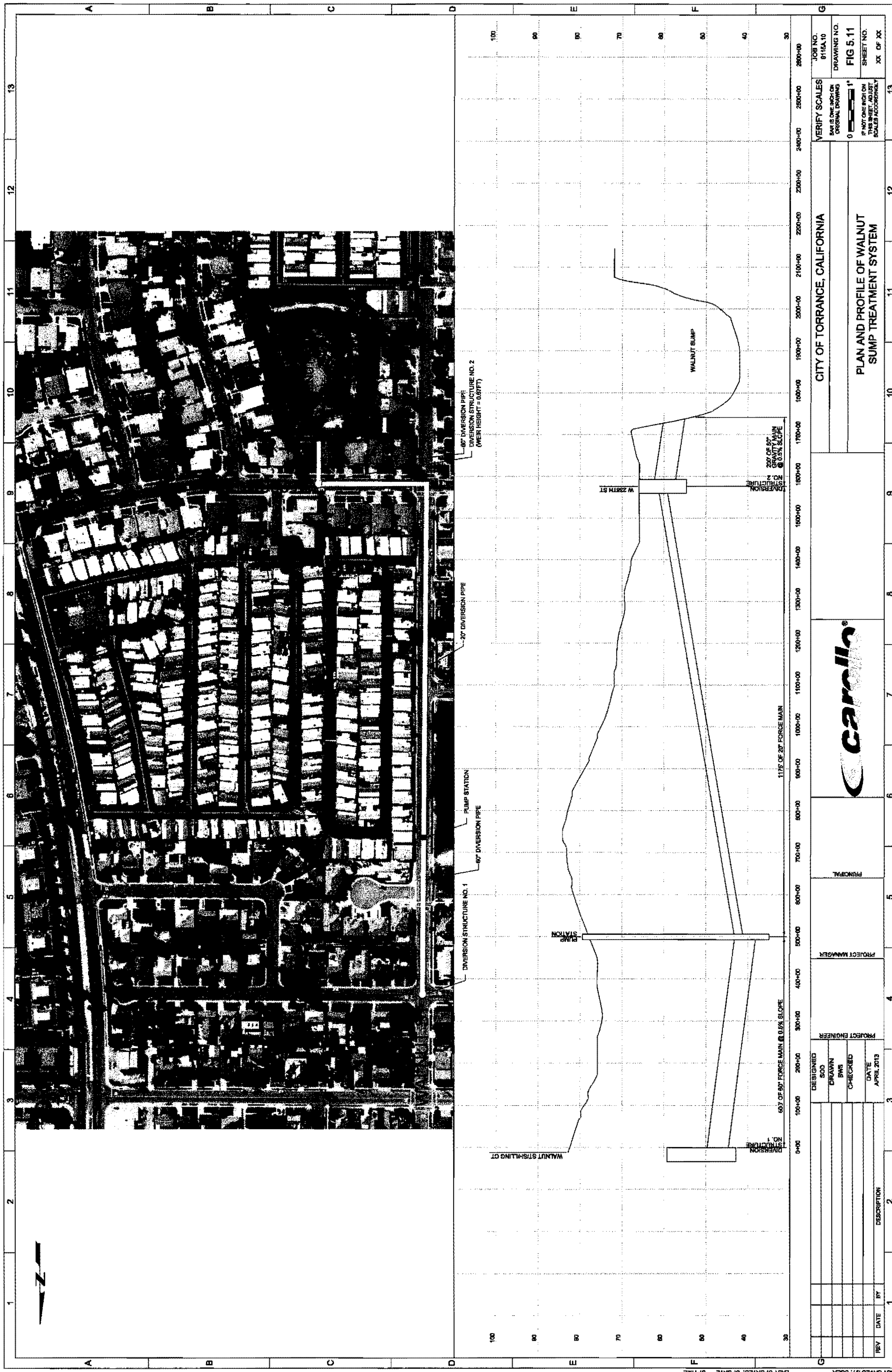
Figure 5.9
Drainage Map of Walnut Sump Treatment Area - Option No. 2
Stormwater Recharge Project
City of Torrance

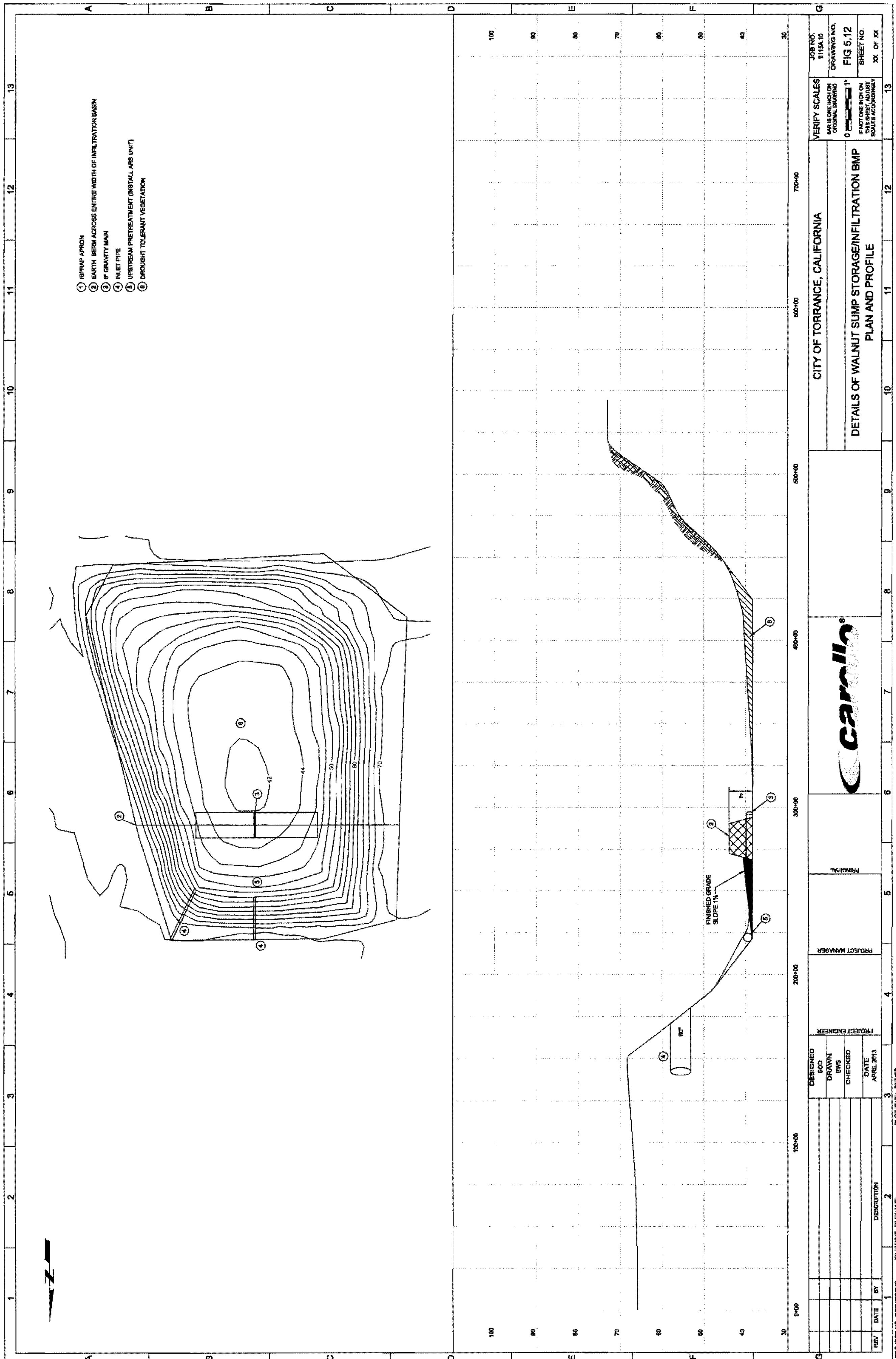
Legend

- Diversions
- Pump Station
- Conveyance
- Walnut Sump
- Storm Drains

0 200 400 Feet

Figure 5.10
Conceptual Layout of Walnut Sump Aboveground Storage/Infiltration BMP
Stormwater Recharge Project
City of Torrance


WALNUT SUMP
W 235TH ST
PUMP STATION
DIVERSION STRUCTURE NO. 1
DIVERSION STRUCTURE NO. 2
60" DIVERSION PIPE
20" DIVERSION PIPE
1175' OF 20" FORCE MAIN
VERIFY SCALES
CITY OF TORRANCE, CALIFORNIA
PLAN AND PROFILE OF WALNUT SUMP TREATMENT SYSTEM
FIG 5.11
carollo
APRIL 2013



1 RIPRAP APRON
2 EARTH BERM ACROSS ENTIRE WIDTH OF INFILTRATION BASIN
3 8" GRAVITY MAIN
4 INLET PIPE
5 UPSTREAM PRETREATMENT (INSTALL ARS UNIT)
6 DROUGHT TOLERANT VEGETATION
FINISHED GRADE SLOPE 1%
CITY OF TORRANCE, CALIFORNIA
DETAILS OF WALNUT SUMP STORAGE/INFILTRATION BMP
PLAN AND PROFILE
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
JOB NO. 9115A.10
DRAWING NO. FIG 5.12
SHEET NO. XX OF XX
DESIGNED
DRAWN
CHECKED
DATE APRIL 2013
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

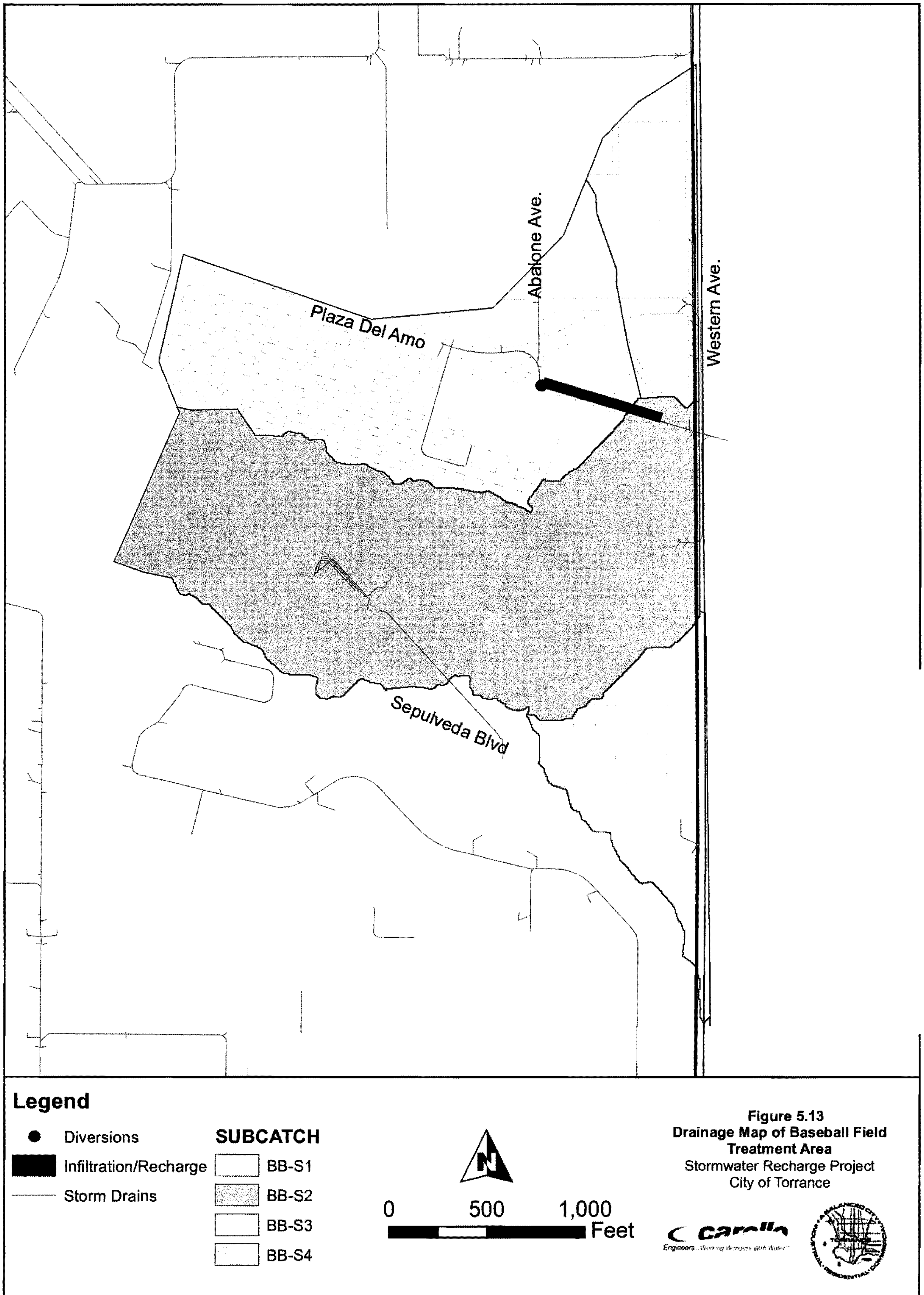


Figure 5.13
Drainage Map of Baseball Field Treatment Area
Stormwater Recharge Project
City of Torrance

Table 5.7 Walnut Sump - Summary of Load Reduction from Quantified BMPs				
	Load (lb/yr)			
BMP Scenario	**TSS**	**TP**	**TN**	**Toxics**
Before BMP	71,451	22	127	5.44
After BMP[1]	66,164	15.9	97.7	5.04
% Load Reduction	92.6	72.1	76.9	92.6

Note:
(1) Load reduction by combined non-structural and structural BMPs

5.3.5.1 Recommended BMP Implementation at Walnut Sump

The overall objective of the Implementation Plan is compliance with the Machado Lake nutrients and toxics TMDLs. The primary objective for this project location, therefore, is to remove toxics and nutrients from the existing storm drain in subcatchment WS-2. These objectives may in general be met by implementing Best Management Practices (BMPs) or a combination thereof. In addition to street sweeping and other non-structural BMPs, the structural BMP proposed for the Walnut Sump drainage area includes the following elements:

- Stormwater lift station.
- 60-inch diameter gravity main
- 24-inch diameter force main
- Flow diversion facility.
- Hydrodynamic separator.
- Above ground storage/infiltration area – Walnut Sump
- Overflow piping.

The implementation will carried out in phases as listed below:

1. Phase I – Divert flow from storm drain 1040
2. Phase II – Install catch basin filters in WS-1
3. Phase III – Diversion and pump station for WS-2

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP at walnut Sump would provide other water resources benefits.

A centralized BMP at this location would be designed to increase infiltration providing additional groundwater replenishment to the groundwater basin. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. For example, the actual BMP design could include additional vegetation that would enhance habitat area in the area and Public Education.

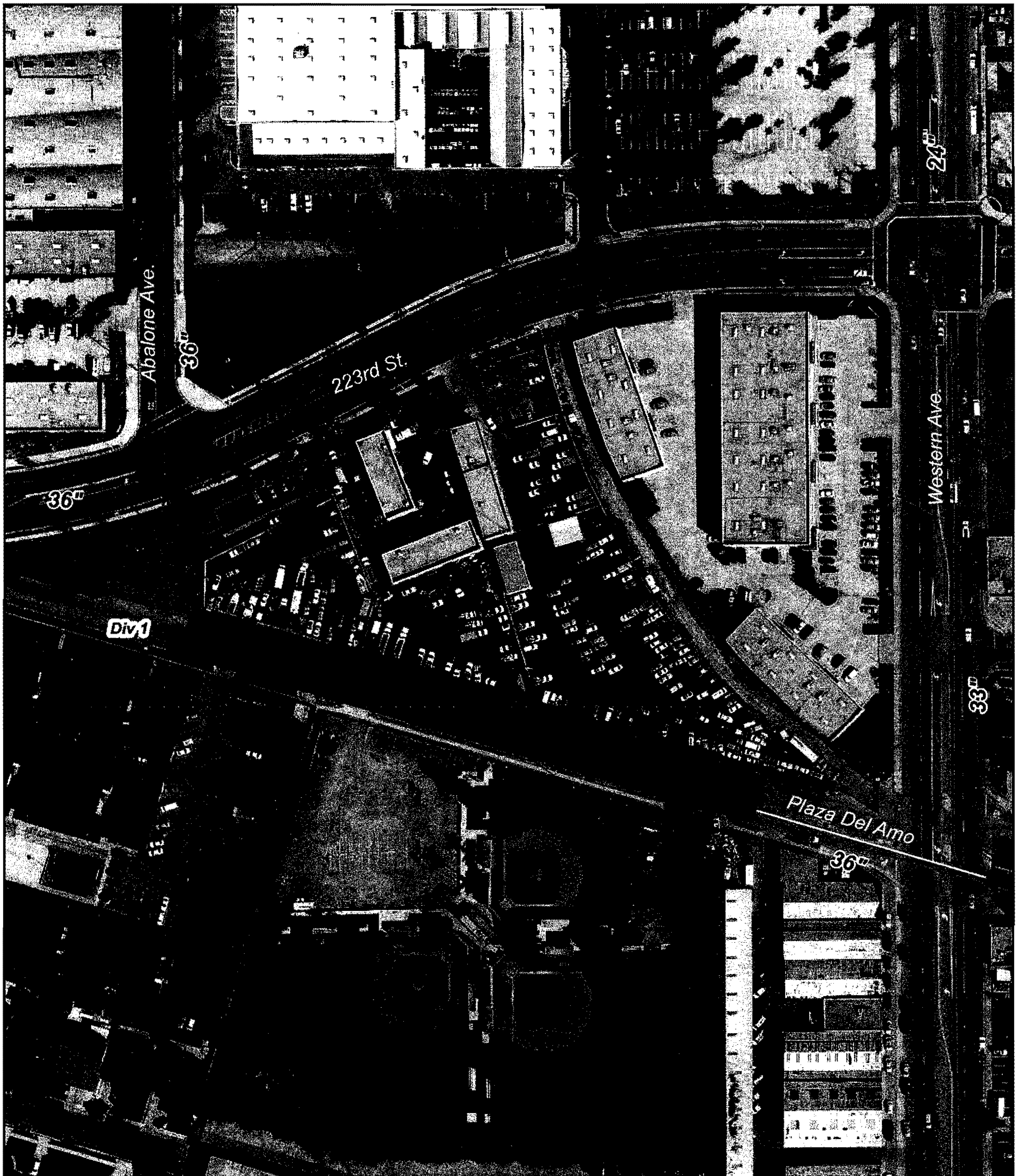
5.3.6 Baseball Field Basin

The watershed treatment area that could be treated by the Baseball Field underground storage/infiltration system is about 60 percent impervious with a concentrated impervious configuration and moderate road density. This treatment area has adequate surface area, about 0.73 acres to treat all the water quality volume generated from this drainage basin. Two treatment options have been identified for this basin. Option No. 1 will treat about 31 percent of the stormwater generated from this area with underground storage/infiltration system. Thus, under this option, only stormwater runoff from sub area BB-S3 shown on Figure 5.13 will be treated with the storage/infiltration system. Stormwater generated from the remaining Sub areas; BB-S1, BB-S2, and BB-S4 will be captured by 19 catch basins retrofitted to allow full capture filters. Option No. 2 will treat the water quality volume generated from the entire treatment area, BB-S1, BB-S2, BB-S3, and BB-S4. Figure 5.13 shows the drainage map of this treatment area and Figure 5.14 is the conceptual layout of this treatment system.

In Option No. 1, stormwater will be diverted from the existing 36-inch diameter pipe at Plaza Del Amo and Western Avenue through a short diversion pipe into the BMP system. Option No. 2 will be considered for implementation when through monitoring and modeling it is found out that more treatment is needed in this subarea. Option No. 2 will capture stormwater runoff generated from BB-S1, BB-S2, BB-S3, and BB-S4. Stormwater runoff will be diverted from existing drain at Plaza Del Amo and Western Ave. into Unit B2. This option also includes the installation of 23 full capture filter screens. Figure 5.14 shows conceptual layout and detail design concept of both options. Table 5.8 summarizes the storage requirements for this treatment basin. Table 5.9 shows the load reduction associated with each option. Figure 5.15 shows the plan and profile of these two options.

Table 5.8 Summary of BMP Requirements – Baseball Field

Option	Area Treated (ac)	Percent Imperviousness	Treatability	Water Quality Volume (ac-ft)	Water Quality Flow (cfs)	BMP Capacity (ac-ft)
Option No. 1	39	63	26.3	0.67	6.0	2.9
Option No. 2	148	65	100	2.54	22.8	6.0



Legend

- Diversions
- Storm Drains
- Infiltration/Recharge
- New Conveyance

0 150 300 Feet

Figure 5.14
Conceptual Layout of Baseball Field
Underground Storage/Infiltration BMP
Stormwater Recharge Project
City of Torrance


DIVERSION STRUCTURE NO. 1
OPTION NO. 1 PIPE
OPTION NO. 2 PIPE
DIVERSION STRUCTURE NO. 2
STORAGE/INFILTRATION UNIT 623' LONG X 53' WIDE X 5' HIGH
OPTION NO. 2 PIPE
15" PIPE @ 1.16%
DIVERSION STRUCTURE NO. 1
DIVERSION STRUCTURE NO. 2
0+00
100+00
200+00
300+00
400+00
500+00
600+00
700+00
800+00
900+00
REV
DATE
BY
DESCRIPTION
DESIGNED SOD
DRAWN BWS
CHECKED
DATE APRIL 2013
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL
CITY OF TORRANCE, CALIFORNIA
DETAIL DESIGN CONCEPT OF BASEBALL FIELD
BMP TREATMENT SYSTEM
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
JOB NO. 9115A.10
DRAWING NO.
FIG 5.15
SHEET NO.
XX OF XX

Table 5.9 Walnut Sump - Summary of Load Reduction from Quantified BMPs				
	Load (lb/yr)			
BMP Scenario	**TSS**	**TP**	**TN**	**Toxics**
		Option 1		
Before BMP	71,451	7	38	1.19
After BMP[1]	63,091	4.97	27.36	1.05
% Load Reduction	88.3	71	72	88.3
		Option 2		
Before BMP	71,451	7	38	1.9
After BMP[1]	65,806	5.04	28.12	1.1
% Load Reduction	92.1	72	74	92.1

Note:
(1) Load reduction by combined non-structural and structural BMPs

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP at Baseball Field would provide other water resources benefits. A centralized BMP at this location would be designed to increase infiltration providing additional groundwater replenishment to the groundwater basin. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. This BMP could be constructed without interfering with baseball field.

5.4 Additional Structural Options for TMDL Implementation

Through additional monitoring, pollutant source characterizations, and site investigations throughout the duration of the TMDL implementation schedule, additional options for structural BMPs could be identified that can enhance or replace those BMPs identified in this plan. This is especially true for dry weather, when flows are highly variable throughout the storm drain system, and specific areas could require special methods treating storm drain flows before they discharge to receiving waters. For storm drains with particularly high dry weather flows and associated pollutant loads where other nonstructural or structural BMPs are not providing a remedy, specific mechanical BMPs can be implemented. Such BMPs could include diversions to wastewater treatment plants or on-site treatment facilities that provide ultraviolet disinfection or other forms of treatment.

Likewise, for wet weather, certain mechanical BMPs can be installed in problem storm drains where other nonstructural and structural BMPs are not providing a solution. Several stormwater BMPs are available for this purpose, which are based on a range of technologies that continue to evolve through continued research and development. This TMDL Implementation Plan is intended to be iterative and adaptive to allow for modifications as additional studies of the drainage system and diagnoses of problem sources are achieved and as new technologies for dry and wet weather treatment continue to emerge.

5.5 Regulatory Requirements and Environmental Permits

Consultation with regulatory agencies and the acquisition of permits is required before project components can be constructed. The following sections summarize regulatory permits and approvals relevant to the implementation of the Water Quality Enhancement Projects in the Machado Lake watershed.

5.5.1 Environmental Assessment

In accordance with the California Environmental Quality Act (CEQA), local agencies are required to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. Every development project that requires discretionary governmental approval will require at least some environmental review pursuant to CEQA, unless an exemption applies. The Water Quality Enhancement Projects discussed in the previous section will likely require the preparation of a Negative Declaration.

5.5.2 U.S. Army Corps of Engineers

Section 404 of the Federal Clean Water Act regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other waters of the United States. The U.S. Army Corps of Engineers (USACE) is the federal agency authorized to enforce Section 404 and issue permits for certain authorized activities conducted in these waters. Based on the proposed area for the projects, it is unlikely that a Section 404 permit will be required. If required and jurisdictional, Section 404 permitting could potentially be completed under the nationwide permit program. Coverage under the nationwide program can be authorized within three to four months from the time the permit application is deemed complete.

5.5.3 U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS), Department of the Interior, is responsible for administering the Federal Endangered Species Act, which prohibits activities affecting threatened and endangered species unless authorized by a permit from the USFWS. The Endangered Species Program is charged with issuing permits for activities that could potentially affect native endangered or threatened species, including Incidental Take Permits associated with Habitat Conservation plans. The USACE will consult with USFWS regarding endangered species issues as part of the Section 404 process. A biological resources report for the project site may be required as part of the permit application package to the USACE.

5.5.4 California Department of Fish and Game

The regulatory functions of the California Department of Fish and Wildlife (CDFW) include the review of CEQA documents as a responsible agency. In addition, CDFW issues streambed or lakebed alteration agreements for projects with impacts to waters of the State, issues permits for take of threatened and endangered species for authorized activities, approves and permits the take of birds, mammals, reptiles, amphibians, non-game fish, and plants for scientific or educational purposes, and the take of threatened, endangered, or candidate species for management purposes. The Water Quality Enhancement Projects may require a CDFW Code Section 1602 Streambed Alteration Agreement.

5.5.5 State Water Resources Control Board

Construction activities disturbing one or more acres must obtain coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Stormwater Associated with Construction Activity Water Quality Order No. 2009-0009-DWQ (Construction General Permit, or CGP). Construction activity subject to this permit includes clearing, grading, and disturbances to the ground such as stockpiling or excavation. To obtain coverage under the CGP, the City will designate a Legally Responsible Person to electronically file Permit Registration Documents (PRDs) with the State Water Resources Control Board (SWRCB). PRDs include a Notice of Intent, Risk Assessment, Site Map, Stormwater Pollution Prevention Plan (SWPPP), annual fee, and certification. A project-specific SWPPP will need to be developed and implemented to reduce polluted discharges from entering the storm drain system and local receiving waters during construction activities. The CGP requires all permitted dischargers to develop and implement a SWPPP that:

- Identifies all pollutant sources including sources of sediment that may affect the quality of stormwater discharges associated with construction activity from the construction site.
- Identifies and eliminates non-stormwater discharges.
- Specifies BMPs to reduce or eliminate pollutants in stormwater and authorized nonstormwater discharges from the site during construction.
- Incorporates BMP inspection and maintenance routines.
- Identifies a sampling and analysis strategy and sampling schedule for discharges that have been discovered through visual monitoring to be potentially contaminated by pollutants not visually detectable in runoff.

The City or construction contractor will need a Qualified SWPPP Developerto prepare the SWPPP, and then a Qualified SWPPP Practitioner will need to implement the plan during construction. The SWPPP must address the use of appropriately selected, correctly installed, and properly maintained pollution control BMPs.

5.5.6 Regional Water Quality Control Board, Los Angeles Region

Under Section 401 of the Clean Water Act, applicants for Section 404 Permits must first obtain a Water Quality Certification documenting that the proposed activity will comply with state water quality standards. If the project is determined to be under USACE jurisdiction, a Section 401 Water Quality Certification will be required for the project.

If the project is not under USACE jurisdiction, the LARWQCB may require coverage under Waste Discharge Requirements instead. Protection of beneficial uses during construction and operation are key issues. Construction dewatering may be necessary because of high groundwater. Dewatering activities will require coverage under the General NPDES Permit and Waste Discharge Requirements of Discharges from Construction and Project Dewatering to Surface Waters in Coastal Watersheds of Los Angeles and Ventura Counties. To obtain permit coverage, a Report of Waste Discharge and application must be filed with LARWCQB at least 30 days prior to discharge.

Even though the installation of Water Quality Enhancement Projects is generally encouraged by the LARWQCB, concerns may be raised with the potential of projects using on-site infiltration of stormwater to affect the water quality of the underlying groundwater. Prior to implementing projects such as infiltration basins/trenches, flow through planters, porous pavement, etc., the City would need to conduct a technical analysis evaluating the possibility of groundwater impacts. The analysis will determine the depth to groundwater, its designated beneficial uses, and the historical uses of the site. There are cases where projects may be infeasible – if the depth to groundwater is less than 5 feet from the surface, if drinking water wells are present within 100 feet of the proposed infiltration site, or if the site is a brown field with potential pollutant mobilization through the soil, etc. Consultation with LARWQCB staff is recommended.

5.5.7 South Coast Air Quality Management District

Construction activities in the South Coast Air Basin are subject to South Coast Air Quality Management District's (SCAQMD) Rule 403. Rule 403 sets requirements to reasonably regulate operations that periodically may cause fugitive dust emissions into the atmosphere by requiring actions to prevent, reduce, or mitigate fugitive dust emissions. The construction contractor will need to implement dust control measures during project construction.

6.0 EVALUATION OF NONSTRUCTURAL AND STRUCTURAL SOLUTIONS

As shown in the previous sections, a number of nonstructural and structural BMP options were identified that can support TMDL implementation. An evaluation of those practices was performed, including optimizing the most cost-effective combination of BMPs to support meeting WLAs for the TMDL Implementation Area. The evaluation analysis for the Nutrient and Toxics TMDLs uses an integrated approach, considering reductions for both classes of pollutants. The evaluation analysis uses the identified suite of structural and nonstructural projects discussed in Sections 4 and 5 to determine the set of actions that will most likely be implemented in an effort to achieve the TMDL requirements. The analysis is a demonstration of how the identified projects may achieve compliance. As the implementation is an adaptive management process, the precise suite of actions and the timing may be changed to use resources more cost effectively. The adaptive management approach will allow changes in the type and quantity of structural and nonstructural BMPs to ensure cost effective measures are being implemented. Flexibility in the schedule and makeup of the Implementation Plan are key to adaptive management.

The quantification analysis is based on the reductions from both nonstructural and structural BMPs that work together to reduce the concentration and load of constituents. Generally nonstructural BMPs consist of pollution prevention activities and source control activities that reduce the amount of the constituent entering the MS4 system, ultimately reducing the concentration in stormwater. Nonstructural activities also encourage the effective use of water, aiming to reduce dry-weather flows. In this way, nonstructural activities reduce the constituent load entering structural BMPs located downstream of the sources.

Removal of suspended sediments by the proposed BMPs will be used a surrogate to assess compliance of Toxics. Toxics removal will be estimated as a fraction of suspended solids removed by the BMPs.

6.1 Evaluation of Structural Solutions

6.1.1 <u>Watershed Modeling and Optimized BMP Selection Approach</u>

Watershed modeling tools linked to a BMP simulation system were used to evaluate and optimize quantitative load reduction scenarios to address TMDL implementation efforts in the TMDL Implementation Area of the Machado Lake watershed. The watershed model is based on existing commonly used to simulate and evaluate BMPs Brief descriptions of the watershed model and BMP simulation model is provided below.

6.1.1.1 P8 - Hydrologic Modeling Using a Continuous Simulation Model

The P8 watershed modeling system utilizes a modeling approach that has been used to support numerous TMDL developments throughout the country. The P8 model is a continuous simulation model and generates runoff characteristics based on rainfall, soil characteristics and infiltration rates, evapo-transpiration, antecedent conditions, and land use specific pollutant loading characteristics. Meteorological data from 2005 to 2013 were used to calibrate the model. Existing meteorological data, hydraulic data, land use information, and monitoring data were used to calibrate each sub-watershed to most accurately simulate the runoff and pollutant load.

The P8 model simulates hydrology, sediment, and general water quality were combined with a stream fate and transport model. Wet-weather loading estimates are developed using the modeled constituents including TN, TP, TSS, and Toxics. Based on the model results from 2005 to 2013, a daily or average annual load was calculated for TSS, TN, TP, and Toxics. Annual load results were compared with the WLAs to calculate the load reduction needed to meet those WLAs and presented in Table 3.5.

6.1.1.2 Optimization BMP Design Approach

The optimization BMP design approach uses GIS information and time-series data for watershed runoff flows and pollutant concentrations (generated by the watershed model), integrates a process-based BMP simulation, and applies optimization techniques for the most cost-effective BMP planning and selection.

Based on comprehensive site evaluation and financial analysis, the City selected five sites for centralized BMP Implementation. Optimization of BMP design approach was therefore not comprehensively performed.

6.1.1.3 BMP Simulation Process

The BMP simulation system uses process-based simulation for BMP function and removal efficiency and accepts flow and water quality time-series data generated internally by P8 as input data. Process-based simulation of BMPs provides a technique that is sensitive to local climate and rainfall patterns. BMP effectiveness can be evaluated and estimated over a wide range of storm conditions, site designs, and flow routing configurations.

The storage/infiltration BMPs used in the study included underground and aboveground storage/infiltration systems. The primary benefits of these BMPs are storage and infiltration, which enable runoff volume and rate reduction. These type BMPs also provide water quality benefits via filtration, settling of sediment, and pollutant decay.

The PLAT was used to estimate the average annual load of TN, TP, and TSS from the TMDL Implementation Area. The model-calculated annual loadings for these constituents are presented in Table 3.5. Additionally, the final WLA and the resulting required reduction for nutrients are included in Table 3.5. The model's estimate for current annual loading of nitrogen is less than the interim WLA, but would require a 30 percent reduction to meet the final WLA. The current loading of phosphorus estimated by the PLAT is also less the interim WLA, but would require a 54 percent reduction in average phosphorus loading by 2018. Load reductions of TSS are are used to estimate toxics removal.

6.2 Nonstructural Quantification Analysis

The Watershed Treatment Model (WTM) is used to assess the effectiveness of nonstructural BMPs on the dry weather and annual loading of nutrients and suspended solids from the TMDL Implementation Area. The WTM was developed by the Center for Watershed Protection with funding by the USEPA in June 2010. The WTM is a spreadsheet-based model that calculates annual pollutant loads and runoff volumes and accounts for the benefits of a full suite of stormwater treatment practices to determine reductions in pollutant loads. The WTM is used for the TMDL Implementation Area in the Machado Lake watershed to determine the accumulated effectiveness of implementing dry weather BMPs for the control of nutrients and suspended solids.

The WTM uses both environmental inputs (e.g., area of land use types, soil types, etc.) and inputs about BMPs. Environmental inputs are used to determine current loads and inputs about BMPs determine the percent reduction in loads.

6.2.1.1 Illicit Connection Removal

Illicit connections to storm drains are sources of a variety of pollutants including nutrients. This source control is applicable to residential and commercial areas in the TMDL Implementation Area. However, the load reduction impact of such program is dependent on the presence and extend of illicit connections in the TMDL Implementation Area. The costs of a field investigation, water sample analysis, and illicit connections trace or to confirm reconnection to the sewer system (via dye, video, or smoke testing) can be highly variable and depend on the extent and nature of the problem. Literature review indicates that the cost of removal of one illicit connection and its reconnection to the sewer system is roughly $2,500 (Marcoux, 2004 and Brown et al., 2004), which makes this is an expensive option. However, the City's NPDES Permit already requires inspection of the storm drain system for illicit connections and removal of the connections, and increased effort to identify illicit connections would enhance the City's illicit connection program. For the purposes of this evaluation, it was assumed that:

- 0 percent of residents have illicit connections. Previous audits conducted by the City did not found any illicit connections.
- 10 percent of businesses have illicit connections,
- 40 percent of the sanitary sewer is surveyed for illicit connections,
- 20 percent of illicit connections are corrected.

Assumptions were based on best professional judgment because the number of illicit connections varies depending on local habits, municipal outreach, and enforcement. The number of illicit connections identified and corrected would be dependent on the resources the City can allocate to this program.

6.2.1.2 Catch Basin Cleanout

Regular catch basin cleanout prevents pollutants from flowing through and into the storm drain system. Sediment, debris, and gross particulate matter are the targeted pollutants with the cleanout of catch basins, but removal of particulate-bound pollutants, including nutrients and toxics, occurs through the physical removal of sediments. Catch basin cleanouts can be prioritized as follows:

- Priority A: These catch basins are cleaned quarterly.
- Priority B: These catch basins are cleaned semi-annually.
- Priority C: These catch basins are cleaned annually.

Review of the City's program showed that most catch basins were Priority C. However, the model only allows input of semi-annual or monthly cleanouts. Therefore, semi-annual cleanouts were selected. Other inputs were based on best professional judgment. The assumption of semiannual cleanouts may overestimate current load removal and therefore underestimate the percent reduction in loads that could be achieved from increased cleanout frequency.

For the purposes of this evaluation, it was assumed that:

- The impervious area drains to the catch basins;
- Catch basins are currently cleaned semi-annually;
- In the future, 60 percent of catch basins will be cleaned quarterly; and
- In the future, 40 percent of catch basins will be cleaned semi-annually.

6.2.1.3 Street Sweeping

Street sweeping uses mechanical pavement cleaning practices to minimize pollutant transport to receiving water bodies. Sediment, debris, and gross particulate matter are the targeted pollutants, but removal of other particulate-bound pollutants, such as nutrients and toxics, can be accomplished simultaneously.

The City's Permit requires that the City prioritize street sweeping as follows:

- Priority A: These streets and/or street segments shall be swept at least two times per month.
- Priority B: Each street and/or street segments is swept at least once per month.
- Priority C: These streets and/or street segments shall be swept as necessary but in no case less than once per year.

For the purposes of this evaluation, it was assumed that:

- Publicly owned roads and parking lots are currently swept weekly.
- All roads in TMDL Implementation Area are currently swept with vacuum sweepers.
- The future program will use vacuum sweepers.

City roads are currently being swept weekly. However, the majority of streets lack proper no-parking signage to allow street sweeping trucks to effectively sweep along the curbs. The City is implementing a signage program to allow enforcement on non-parking days and increase the effectiveness of the current street sweeping program. The City uses both mechanical and the more effective vacuum sweepers. The street sweeping cost (including O&M) of vacuum street sweepers is $360/curb mile based on a monthly sweeping frequency (in 2005 dollars) (Shilling, 2005).

6.2.1.4 Residential Irrigation and Fertilizer Reduction

Over irrigation leads to runoff, increasing flows within the stormwater system. Additionally, urban irrigation runoff can be high in TSS and nutrients. The nutrients in urban irrigation runoff are typically from fertilizers, which are often overused. Effective outreach can teach residents not to overwater and to test the soil to determine the appropriate amount of fertilizer to apply. In addition, evapotranspiration (ET) controllers have been successfully used to reduce irrigation runoff. The cost of this outreach is highly dependent on the approach, which could vary from internet outreach sites to homeowner incentives to educational displays at retail stores.

For the purposes of this evaluation, it was assumed that:

- Half of runoff from the TMDL Implementation Area is dry weather flow.
- An irrigation reduction program would reduce irrigation flows by 20 percent.
- Enhanced outreach of television and radio spots would be necessary to reach and convey the message of controlling irrigation and using proper amounts of fertilizer.

6.2.2 Results of Watershed Treatment Model

The results of the above combined inputs to the WTM are listed in Table 6.1. The reductions are based on percent of dry weather load and the percent of annual runoff load (e.g., street sweeping has benefits in both wet and dry weather). These reductions are considered approximate estimates due to the environmental characterization assumptions made for the model and the assumptions listed in the previous sections.

Table 6.1 Estimated Reductions in Nutrients and TSS from Non-Structural BMPs

	Percent Reduction(1)			
Flow Condition	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Toxics
Dry Weather Runoff	21%	15%	33%	33%
Annual Runoff	23%	10%	26%	26%

Note:
(1) Load reductions as predicted by the Watershed Treatment Model with inputs discussed in Section 6.2.

WTM requires a number of inputs to assess current conditions and the effectiveness of specific source controls. The WTM is the best available tool for modeling and estimating reductions because there is very little reliable literature about load reduction in stormwater through implementation of nonstructural BMPs. WTM results will need to be compared with and used in conjunction with stormwater quality and quantity data to evaluate the effectiveness of the nonstructural BMPs.

As shown in Table 6.1, the use of nonstructural BMPs is estimated to reduce TP loading by 10 percent on an annual basis. Therefore, the remaining 44 percent of the required 54 percent reduction (see Table 11) will need to be through the use of structural BMPs. Similarly, structural BMPs need to remove the remaining 8 percent of the required 31 percent of TN removal as calculated with the models and assumptions stated in this report.

6.3 Structural Quantification Analysis

The PLAT calculates the distribution of structural BMPs to provide the required load reductions at the optimal cost. In setting the load reductions levels for structural BMPs in the PLAT, the anticipated reductions through implementation of non-structural BMPs are subtracted from the total load reductions necessary to achieve the TMDL WLAs. Structural BMPs considered in the PLAT include rainwater capture and reuse, bioretention, porous pavement, and centralized treatment. The initial recommendations for structural BMPs optimized by the PLAT are presented in Table 6.2.

Table 6.2 Optimized Sizing of Centralized BMPs from PLAT[1]					
			Centralized BMP Needed (ac-ft)		
Sub Area	Total Area (ac)[1]	Impervious Area (%)	Aboveground	Underground	Total BMP Treatment Capacity (ac-ft)
Airport - AS2	86	45	n/a	1.5	12.0
Airport - AS3	640	59	n/a	28	38.0
Airport - Walteria	391	60	n/a	20.5	22.4
Walnut Sump	-	-	39.5	n/a	50
Baseball Field	-	-	n/a	1.0	2.9

Note:
(1) Overall removal load reduction percentages: TSS=90%; TP=68%, TN=70%; Toxics=90%.

The final mix of BMPs will depend on funding available for installation and the measured gains in nutrients and toxics reductions as projects are implemented. Refinements to the model based on Machado Lake watershed water quality and quantity monitoring may also change the amounts and relative distributions of BMPs in future reconsideration of the Nutrients TMDL.

6.3.1 Retrofit through Redevelopment

Additionally, the City will adopt an ordinance requiring LID components when greater than 50 percent of the impervious area is modified. Residential areas within the TMDL Implementation Area are generally established with low levels of redevelopment. The commercial and industrial areas may experience a moderate rate of redevelopment and would be subject to the City's LID ordinance.

For purposes of this evaluation, it is assumed that 15 percent of the 675 acres commercial, industrial, and institutional area in the area will experience redevelopment over the course of the Implementation Plan. In addition, the rate of redevelopment is assumed to be 2.5 percent per year between 2013 and 2018. This rate is based on the levels experienced in the TMDL Implementation Area of LA County over the past 20 years and is expected to be similar in the TMDL Implementation Area over the life of the Implementation Plan.

Future rate of redevelopment are largely a function of the economic health of the region as a whole and is outside the control of the City. In the future, if the levels of LID through redevelopment becomes more significant that assumed for this study, it could be possible, that less structural BMPs are required in the TMDL Implementation Area to meet the WLAs.

6.4 Quantification Analysis Results

A summary of the required BMP capacity volumes and identified volumes though City projects, redevelopment, and identified opportunities is presented in Table 6.2. The remaining BMP capacity (i.e., the BMP capacity not identified through retrofit of City lands, conceptual opportunities, or redevelopment) may be provided through private installation of BMPs or the installation of structural BMPs within leased properties or acquisition of land within the TMDL Implementation Area. Leasing land area will require negotiation with lessees on properties where leases will expire during the implementation period. Private installation of BMPs may occur through incentive programs, or ordinances. Stormwater fees may be developed to provide a funding mechanism for future BMPs and fund (not oversee) the programs discussed in the BMP Implementation Plan. To attain the WLAs, it may not be necessary for the City to acquire land outside the Implementation Area to implement BMPs. Successful implementation of the programs to attain WLAs will require the multi-departmental detailed planning which is beyond the scope of the BMP Implementation Plan. The BMP Implementation Plan is rooted in an adaptive management approach, allowing the City to assess the true effectiveness of non-structural BMPs, and monitoring to better refine the annual average load of the pollutants of concern. To attain WLA, City may need to work with LACFCD and Rolling Estates to expand Project A1 at the Torrance Airport.

6.5 Quantification Analysis Conclusions

Due to the reasonable amount of existing publicly owned land within the TMDL Implementation Area in the Machado Lake watershed, centralized structural BMPs can be implemented in areas currently owned by the City. This avoids lengthy negotiations between landowners and the City, incentive programs, City ordinances, and stormwater fees may need to be developed and instituted, and land acquisition may be necessary.

The monitoring program will provide stormwater sampling data to assess the site-specific level of nutrients associated with the sediment leaving TMDL Implementation Area. The measured pollutant levels from the monitoring program may provide more site-specific pollutant loading scenarios from the watershed, which would help reevaluate reductions required to meet the WLAs. Currently, TP is the limiting constituent driving the number of BMPs. Additionally, the Nutrients TMDL is due to be reevaluated by 2016, and the reevaluation will include the information from special studies and the results of monitoring programs. The Nutrients TMDL reevaluation may be used to refine the loading capacity of Machado Lake, ultimately changing the WLAs. If, through monitoring, the loadings from the TMDL Implementation Area reveal that nonstructural BMPs are more effective than assumed by the WTM, or the levels of constituents in the runoff from TMDL Implementation Area are lower than currently thought to exist, BMP implementation will need to be adjusted accordingly.

6.6 Reasonable Assurance

The main objective of this implementation plan is capture 85th percentile runoff and infiltrate it, wherever possible. This is in addition to non-structural BMPs including enhanced street sweeping, public education and catch basin filter inserts. The City is already performing street sweeping and public education. The proposed BMPs have sufficient capacity to capture and infiltrate the 85th percentile runoff. The expected phosphorus removal is summarized in Table 6.3. The cost per phosphorus load removed by each of the proposed BMPs is shown on Figure 6.1 and Figure 6.2 shows the expected phosphorus removal throughout the implementation period.

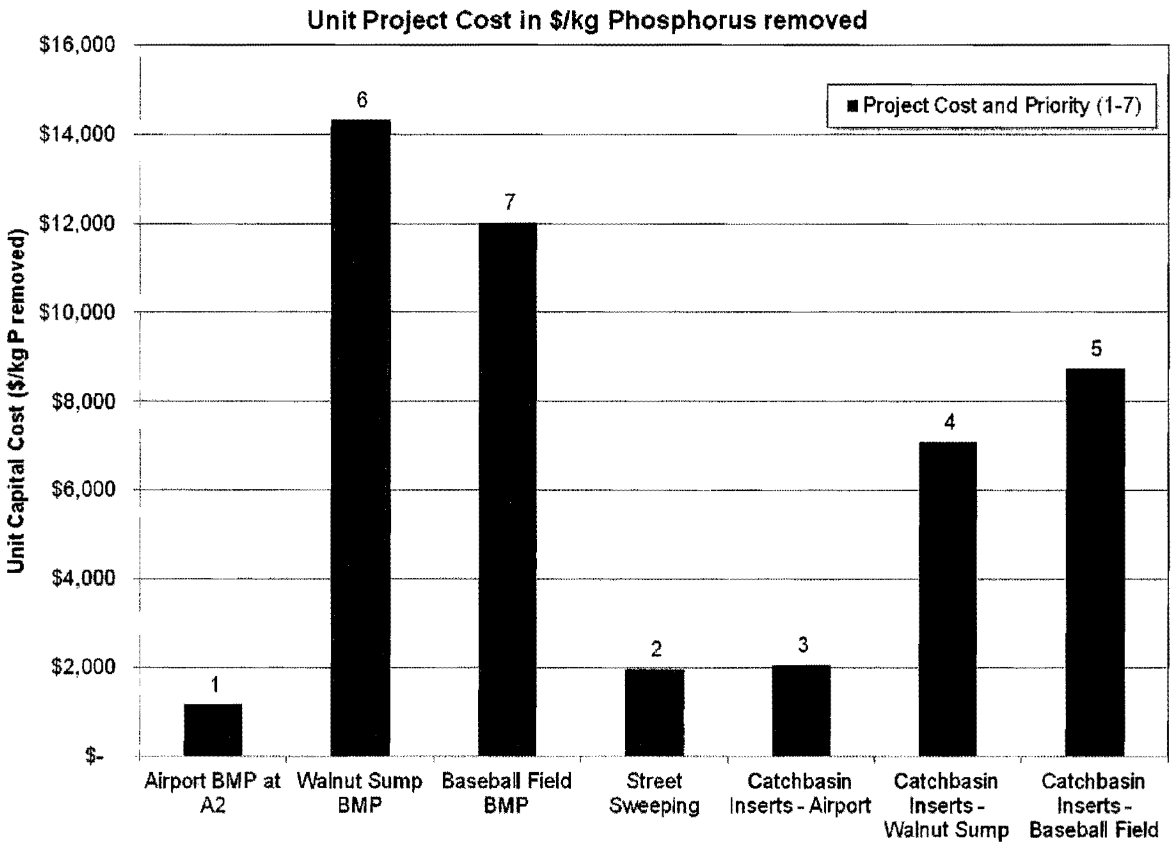


Figure 6.1 Cost per TP Load Removed By Each BMP

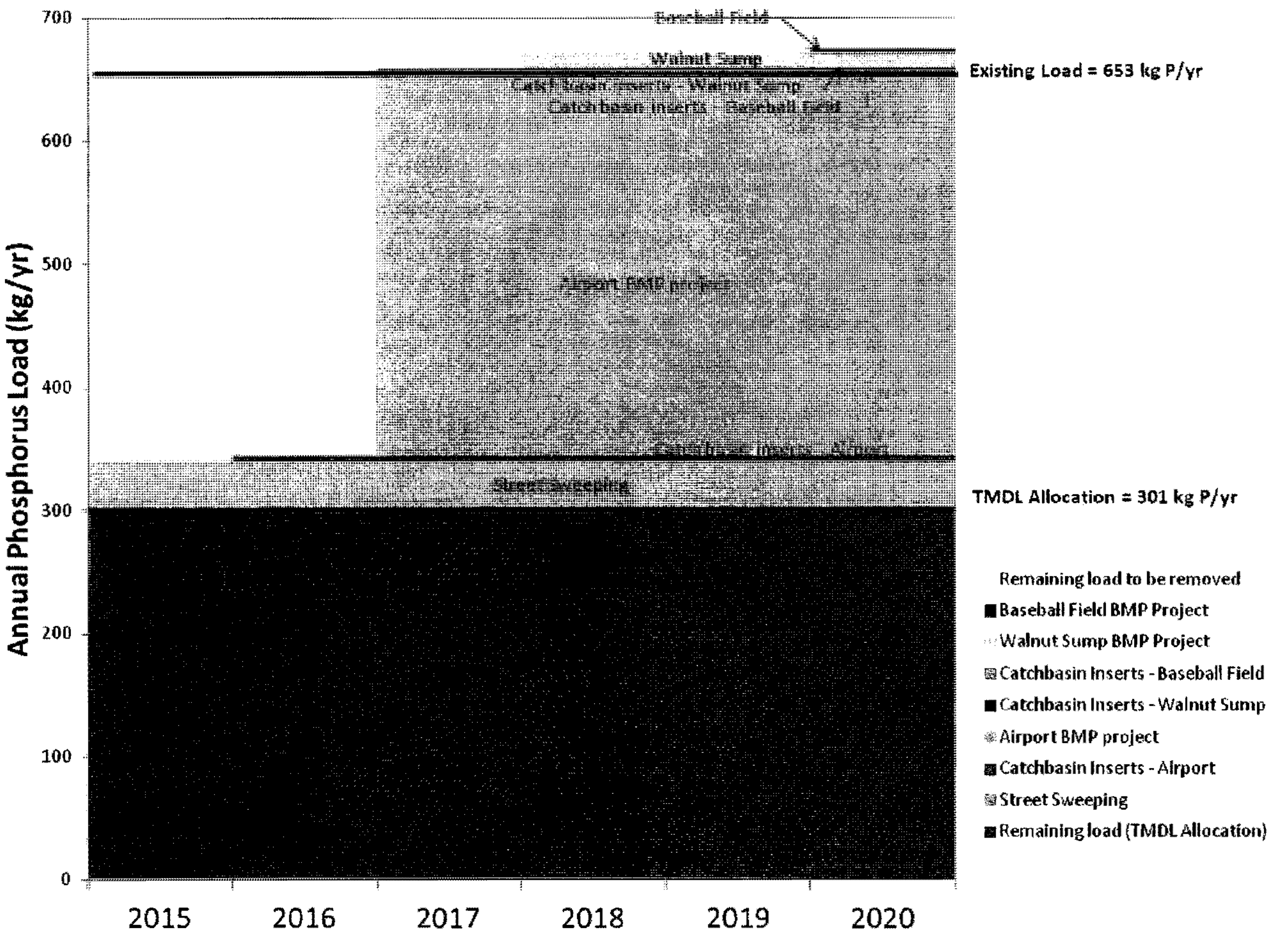


Figure 6.2 Expected TP Removal throughout the Implementation Period

Table 6.3 Summary of Expected Phosphorus Removal

Project Location	Subcatchment	Drainage Area (ac)	Total No. of Catchbasins	Proposed No. of Catchbasins	Baseline Load for TP (kg/yr)	Load Reduction from Structural BMPs (kg/yr)	Load Reduction from Street Sweeping (kg/yr)	Load Reduction from Catch Basin Inserts (kg/yr)	Total Load Reduction (kg/yr)	Strucutual BMPs Captial Cost	Street Sweeping Captial Cost	Catch Basin Inserts Captial Cost	Total Capital Cost	$/kg removed	30
					BASELINE LOAD AND LOAD REDUCTION										
	AS1	391	57	57	167.8	6.7	5.0	5.1	16.8	$ 128,500	$ 138,293	$ 125,400	$ 392,193	$ 766	
Airport	AS2	86	0	0	40.8	27.6	2.9	0.0	30.5	$ 7,031,000	$ 30,417	$ -	$ 7,061,417	172328.431	
	AS3	640	0	0	410.5	278.9	28.7	0.0	307.6		$ 226,362	$ -	$ 226,362	$ -	
	Subtotal	***1,045***	***173***	***57***	***619.1***	***313.2***	***36.6***	***5.1***	***354.9***	***$ 7,159,500***	***$ 369,606***	***$ 125,400***	***$ 7,679,972***	***$ 173,094***	***$ -***
Walnut Sump	WS-1	742	50	50	17.7	0	1.2	1.3	2.5	$ 125,000	$ 262,438	$ 110,000	$ 497,438		
	WS-2	181	192	0	4.3	12.9	0.3	0	13.2	$ 3,488,000	$ 64,018	$ -	$ 3,552,018		
	Subtotal	***923***	***242***	***50***	***22.0***	***12.9***	***1.5***	***1.3***	***15.7***	***$ 3,613,000***	***$ 326,456***	***$ 110,000***	***$ 4,049,456***	***$ -***	***$ -***
Baseball Field	BB-S1	16	5	5	0.4	0	0.03	0.1	0.13		$ 5,659	$ 11,000	$ 16,659	$ -	
	BB-S2	50	9	9	1.3	0	0.09	0.2	0.28		$ 17,685	$ 19,800	$ 37,485		
	BB-S3	39	4	0	1.0	2.1	0.07	0.0	2.19	$ 500,000	$ 13,794	$ -			
	BB-S4	50	5	5	1.3	0	0.09	0.1	0.20		$ 17,685	$ 11,000	$ 28,685		
	Subtotal	***155***	***23***	***19***	***4.0***	***2.1***	***0.3***	***0.4***	***2.8***	***$ 500,000***	***$ 54,822***	***$ 41,800***	***$ 82,828***	***$ -***	***$ -***
Walteria Lake	WL	***2,118***	***0***	***0***	***7.0***	***0***	***0.5***	***0***	***0.5***	***0***	***$ 749,116***	$ -	***$ 749,116***		
Totals		4,241	438	126	652	328	39	6.8	374	11,272,500	1,500,000	277,200	12,561,372	173,094	0